SCIENTIFIC AMERICAN

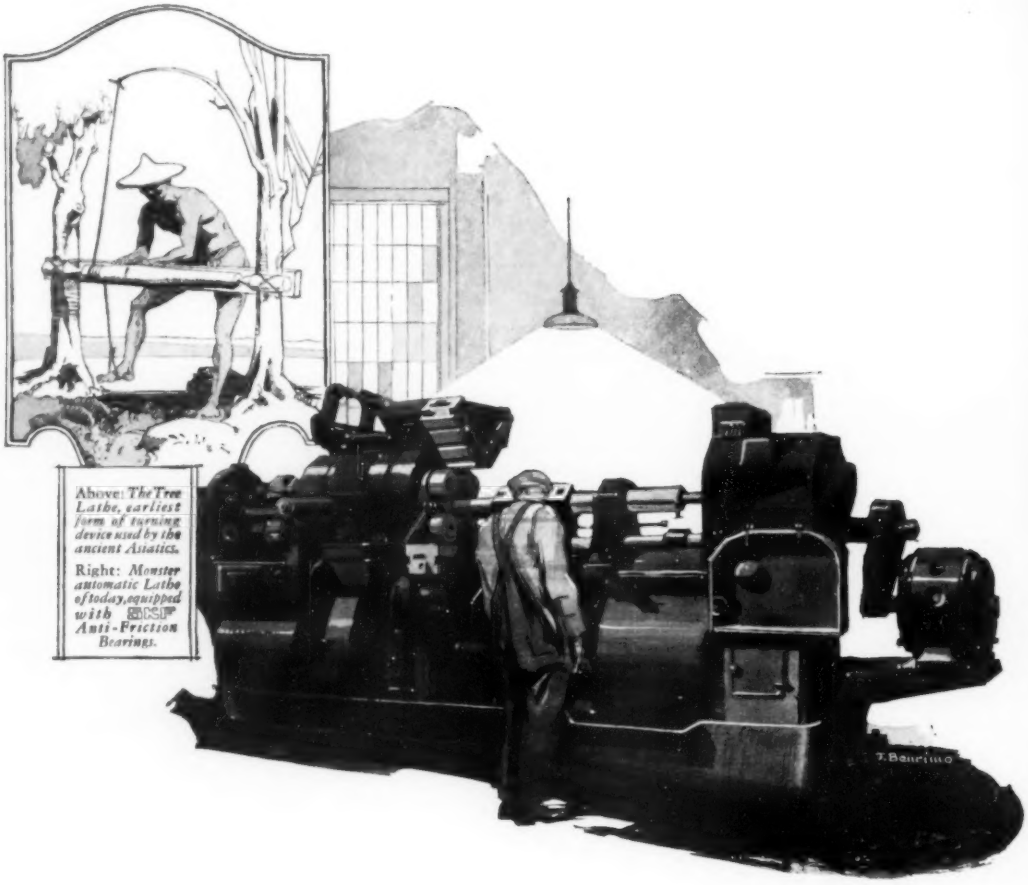
NOVEMBER 1927 *Thirty-five Cents a Copy*

ARE HUMAN "ENGINES" EFFICIENT?

BY DR. PAUL R. HEYL

EVOLUTION OF THE HUMAN EYE

WHAT IS NEW IN RADIO?



Above: *The Tree Lathe, earliest form of turning device used by the ancient Asiatics.*

Right: *Monster automatic Lathe of today, equipped with* SKF *Anti-Friction Bearings.*

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SCIENTIFIC AMERICAN

November 1927 *Edited by* ORSON D. MUNN Eighty-third Year

Soap

WE have all met people who deride science. Scientists amuse them. Scientists do queer things and have such queer ideas. They make queer mistakes and—well they're just a little queer themselves, you know.

A man harangued one of our editors in that vein the other day, for half an hour, while both rode to New York on a commuters' train, crossed on a ferry, rode again in a subway. "The world would have been better off without it," he said, summing up against science. And almost in the same breath he "knocked" the subway for being slow.

That man lives in a house that without the benefits of science would have been a dimly-lighted hovel, he travels on trains made possible only by science, and, we noted, conversed about the enjoyment of his radio (no science, no radio), his car (ditto), mentioned making a 'phone call (science), wore glasses fitted by science, and was literally surrounded by the results of science, of whose benefits and significance he never took time to reckon. And there are lots more like him.

We wished that, for a day, we could have abolished the conquests of science and set him back in the Ages of Faith, the early Middle Ages. He couldn't even get his face clean. Soap is a product of science!

Bunk

WE received the other day a frantic letter of inquiry. "Is it true." we were apprehensively asked, "that the SCIENTIFIC AMERICAN has weakened in its former stand against the Electronic Reactions of Abrams and the technique of the Abrams Oscilloclast?"

Our reply was "No, we have not weakened—we are still unable to see the light." Unregenerate, we still regard the E. R. A. and the oscilloclast or 'Abrams Box' as bunk."

And, so to speak, "that's that."

Ham-and-eggs

ONCE again tradition has received the indorsement of science. After ten years' experiments in which 4000 alboin rats have been fed, the Department of Agriculture reports that ham and eggs are an ideal food combination.

"The work has shown lean pork to be rich in vitamin B, but, on the other hand, low in the fat-soluble vitamin A," Ralph Hoagland, biochemist in the Bureau of Animal Industry, finds. "But when one considers that so many pork products are commonly eaten with eggs, which are rather low in vitamin B but rich in vitamin A, the nutritive value of the combination is apparent. Thus, meals containing ham and eggs, or bacon and eggs, furnish a liberal supply of these two important food elements, besides fat, protein, minerals and other desirable constituents."

CONTENTS

NOVEMBER 1927

DEPARTMENTS

Hair

HUMAN-HAIR imports from China have been increasing steadily since the first of the year. In January shipments were 21,334 pounds. By April they had more than doubled; 59,438 pounds valued at 20,110 dollars were received.

Does this mean our wives are going back to long hair and are about to use switches in the growing period? Have they been concealing something from us?

Egypt

THEY have been taking a census in Egypt. Its object is explained as follows: "The purpose of the old census was to learn how the people could better serve the state; that of the present census is to determine how the state may better serve the people."

Not only all of the dwelling houses, but even the tombs which shelter living humans have been canvassed and the police have rounded up the vagabond population. It is important. Egypt is facing a crisis in her history. She is within sight of complete exploitation of all lands that can be watered by the Nile, and she is turning from dependence upon agriculture to dependence upon industry and commerce. She must know how many mouths she has to feed and where the food is coming from.

Cover

THE subject of our cover this month is taken from the article, "Head Hunters of Burma," starting on page 393 of this issue. The painting was made from photographs of a Naga warrior and of a display of human skulls found before a native's hut. The warrior, as told in the article, has an elaborate head-dress of hornbill feathers and wears a "tail" from which depends long, dyed human hair. More details of the curious people of which this warrior is one, will be found in the article.

Among our Contributors

DR. PAUL R. HEYL

Dr. Heyl, author of the thought-provoking scientific-philosophical dialog on page 396, is a research physicist at the United States Bureau of Standards at Washington. His most recent achievement was reweighing the earth, whose avoirdupois was not precisely known. Despite preoccupation with much scientific research Dr. Heyl finds time to *think*—as those who read his article will agree.

PROF. H. AUSTIN TAYLOR

In the issue of last March we presented an article by Prof. Hugh S. Taylor of Princeton. We now publish one by Prof. H. Austin Taylor, Prof. Hugh S. Taylor's brother, of the Department of Chemistry at New York University. His subject is "phosphorescence." Both brothers understand well the art of popularizing science without resort to that abomination, "writing down" to the laymen readers.

Dr. Morris Fishbein

Each month Dr. Fishbein places before our readers a survey of the most timely and significant developments of medicine and surgery. As editor of the *Journal of the American Medical Association* (Chicago) he writes from a high vantage point: his own journal is read by two-thirds of America's doctors.

Harold J. Shepstone

This month we publish another of Mr. Shepstone's interesting articles—on the head-hunters of Burma. As a Fellow of the Royal Geographical Society he is in a strategic position to deal with travel, exploration and archeology. He has traveled widely and made a specialty of the things of which he writes.

W. E. Bailey

Mr. Bailey has embodied in a most engaging article the conclusions of a noted eye specialist and scientist concerning the origins of eyesight in animals, and that scientist has read Mr. Bailey's article in manuscript and given it his imprimatur. The theory in question is well supported by scientific observations.

D. H. Killeffer

Our chemistry editor is also Associate Editor of the technical publication, *Industrial and Engineering Chemistry* (New York). This is the official organ of the great American Chemical Society, of whose New York Section Mr. Killeffer is Chairman—a capacity in which he maintains close touch with chemistry.

Looking Ahead

with the Editor

UNCANNY

A newly discovered method now being developed by Dr. Robert H. Gault, working under the aegis of the National Research Council, enables the totally deaf to learn to hear with their finger tips. To witness a group of these pupils taking in spoken words in this peculiar manner is most uncanny. In a forthcoming issue Dr. Gault will tell of his work.

RECONQUEST

A glacier plows down across a continent, scours away and obliterates every living thing in its path and later recedes. A thousand years afterwards Nature has put back the plants, shrubs and trees removed. A matter-of-fact happening, you say? Study it closely. Perhaps to your surprise it will become evident that Nature works in a remarkably systematic manner. How this occurs will be told.

LIGHTNING

In an early issue an engineer on the staff of a great oil company will explain how a new method of lightning prevention has been developed to protect immense oil storage tanks. Can lightning actually be *prevented?* Obviously yes—for it is *being* prevented now. The inventor will describe his method.

ANCIENT

The interior of the great Arabian Desert remains almost unexplored. A noted archeologist will narrate the story of a journey across recently made, in which evidences of man of 20,000 years ago were actually found lying on top of the ground, waiting to be picked up. Here is an article which will make you want to organize your own expedition!

PAINLESS?

Do insects feel pain, like other animals? When injured they squirm as if they did, yet one naturalist says they feel only discomfort. Some remarkably interesting experiments have been performed, and a few will be described soon.

PROFESSOR ELIHU THOMSON

Dr. Thomson, an electrician, is Director of the well-known Thomson Laboratory of the General Electric Company at Lynn, Massachusetts. During his many years of work in the electric lighting and power field he has made more than 500 inventions. Among these perhaps the most notable is electric welding. He has been honored with many medals and by election to membership in American and foreign scientific societies, and is a member of the National Research Council and the National Academy of Science. For a time he was acting President of the famous Massachusetts Institute of Technology ("Boston Tech"). His life work has spanned the vast development of the electrical industry. He is still actively engaged in research

Wide World

Six At a Time!—English Parachute Jumpers

At a recent air carnival held at Heddon air-field, England, a spectacular feat that was not on the program was performed. Because of the impossibility of being sure that conditions would be right for the unusual attempt that was secretly planned, word of it was not released to the public until the planes had taken off. Then the loud-speakers of the public-address system, through which announcements were made, suddenly informed the crowd that they would shortly witness a most unique display of parachute jumping. Three Vickers Vimy planes were in the air, and the spectators could see a tiny figure crouching on each wing-tip of each of the planes. These were parachute jumpers, six in all, clinging to the upright struts that brace the wings. At a given signal they all pulled the rings that released the parachutes and were pulled off the wings. Each of the parachutes opened perfectly, and the six aviators floated safely to the ground.

IMBUED WITH THE SPIRIT OF THE DANCE

Two native girls dancing to the rhythm of a chant by a group of the men

Head Hunters of Burma

How England, at Considerable Cost and Peril, is Obtaining the Freedom of Thousands of Slaves from the Tribes in the Naga Hills

By HAROLD J. SHEPSTONE, F. R. G. S.

An Ao Warrior

SLAVERY and human sacrifices within sight of the British flag sounds a little startling. Yet last summer no fewer than 3445 slaves were given their liberty in the Naga Hills at a cost to the Burma Government of just over 5000 dollars. This season almost as many slaves have been released by the various columns now operating in these mountain fastnesses.

Although on the whole, success has attended Captain Barnard's present expedition, he is nevertheless finding the work exceedingly dangerous and trying. One of his officers, Captain West, in charge of one of the emancipation parties, has been killed, as well as two of his Gurkha escort. The fact is that the tribes inhabiting these mountains are not only very warlike, but are inclined to resent the intrusion of any strangers.

The Naga Hills constitute one of the most curious frontiers in the world. The region consists of great mountain ranges, towering 10,000 feet and more in height, stretching for a distance of some 500 miles, and varying from a few miles to nearly 100 miles in width. On one side lies the valley of the Chidwin and Irrawaddy. Although these mountains lie between two fertile provinces, with their railroads, roads and steamer services, they are as yet largely unexplored. Here dwell the Nagas, among the most primitive and picturesque of savage tribes to be found anywhere in any region in the world.

In this mountainous territory, which is very difficult to penetrate, there are fully a score of different tribes. Although they vary considerably in physique and temperament and in manners and costumes, they are all very warlike. The villages in which they dwell are invariably built on the very summits of the spurs and ranges, and ingeniously guarded against surprise attack.

THE villages are surrounded by a thick, impenetrable wall of living cane, with terrible reversed thorns. This fence in turn is often further strengthened by a ditch, while the approach to a village is by means of a tunnel under the cane, the latter being tied up by stakes. On the approach of an enemy the cane is allowed to fall and block the tunnel. Should an invader get through this, he would find himself confronted by a ditch from which the plank had been removed, bristling with *panjis*—sharp-pointed bamboo spikes that will pierce a man's foot.

It was because of the head-hunting propensities of these warlike hill tribes that the Indian Government, to protect the workers in the plains from raids, took over the administration of the Naga Hills. One officer is stationed at Kohima, in Angami territory and another at Nokokchung, among the Aos. They are administering only a portion of the territory, the idea being that the government should extend its influence gradually by peaceful penetration. In the unadministered areas, however, head-hunting and human sacrifices are still indulged in and the aim of the government is to endeavor to put down these practices by sending expeditions into these partially explored regions to buy slaves and set them at liberty.

All travelers are agreed that the Nagas are among the most picturesque savages in the world. They are great lovers of feathers, ornaments and bright colours. The ceremonial costume of the warriors is in some respects

AN AO WOMAN

The characteristic head rings are of brass, while the necklaces are composed of cornelian beads and white metal ornaments

magnificent. They wear headdresses of hornbill feathers which are so adjusted that they readily turn in the wind, as otherwise they would break. Around their bodies are baldrics, or scarfs, embroidered with scarlet hair, from which depend aprons of cloth completely covered with cowrie shells.

Their most characteristic ornament, perhaps, is a tail of human hair, also dyed scarlet. In the old days the hair was taken from the head of a dead enemy, but in the administrated areas girls with fine hair sell their tresses for this purpose and grow another crop. The warriors' weapons consist of a spear and a *dao*, the latter being a kind of chopper-shaped axe. With it a Naga can slay an enemy, cut up a chicken, fell a forest tree, pare down the finest strip of cane, dig a hole for a post or cut a thorn out of his foot.

Striking features of the dress of the women are their head ornaments of brass rings and ropes of cornelian and conchshell beads. A Naga woman will take as long in adjusting her head ornaments as a western lady will in putting on her hat. Their ears are pierced and all sorts of earrings are favored—pieces of crystal rock, bunches of bright red chillies and the feathers of some bird. Their skirts are made of native cloth and in some tribes they are beautifully ornamented with white, red and dark blue bands.

A CHANG CHIEFTAIN

The boar tusks and the shells depending from his ears denote that he has taken heads. He is sipping rice beer through a tube, a characteristic Chang habit

By nature all Nagas are head-hunters and those chiefs in the administered areas, where the taking of these ghastly trophies is not allowed, bemoan that fact and speak with disgust of the prospect of "dying like cows" in their own beds.

Now, a Naga takes heads for two main reasons. He wishes to bring home tangible proof that he has slain his enemy, and he also wishes to obtain the soul of his enemy, so that the soul-power of his village may be re-enforced and its prosperity and fertility increased. The heads taken are those of a rival tribe.

THE FAMILY BARBER

A native father cutting his son's hair. The hair is wetted and then shaved with a piece of broken metal

Occasionally, slaves are sacrificed, although here it is difficult to learn exactly what happens, as slavery is not permitted in administered territory. So far as one is able to discover, the victim is given special food and made a great fuss of before the fateful day. They apologise to him for any inconvenience he will be caused, and point out the great honor that is being done to him in sacrificing him to the harvest gods. He is given copious draughts of *madhu*, or rice beer, and there is no doubt that he is in a state of stupor when his time for departing this world arrives.

SOME tribes expose the heads they take on the top of bamboo poles; others place them on the branches of the sacred tree of the villages, and other tribes keep them in the chief's house, or in the *morungs* or bachelors' houses, or under sacred stones. Occasionally one finds a human head with a dog's skull above it. This is done in case the man's relatives should ask him in dreams who killed him. When he replies, the dog barks and thus drowns his answer!

The reverence in which the human head is held by these primitive people is most extraordinary. The Konyaks, a particularly warlike tribe, give special treatment to the head after ordinary death, believing that it contains a man's soul. It is taken from the body, cleaned and brought into the house, where it is visited by friends of the deceased, who bring gifts and express their grief. The head of a young buck will be visited by the girls among whom he was popular; they will sob and lay before the head little quids of betel-nut, reminding the departed of the happy days they had together.

One of the administrative officers of the Naga Hills, Mr. J. P. Mills, related to the writer how he assisted a deposed chief of the Chang tribe in regaining his throne. A few months later he received a present from him—a human head which the chief declared he had taken with his own hands; and was quite grieved when the present was refused.

Every village is independent and governs itself. Some are ruled by chiefs and others by a body of councillors. The appointment of the latter and the varied duties they have to perform are all rigidly prescribed. When the time comes for the councillors to vacate office there is invariably a great deal of argument, the office-holders contending that their time is not up and the younger men insisting that it is.

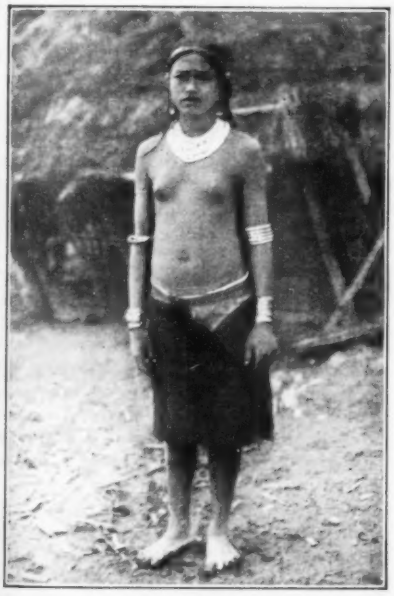
TO the westerner the methods of the councillors may appear a little strange, but they are effective. A fine for breaking the law may be so many baskets of rice or a pig, and the councillors have a happy knack of partaking of the fine first and finding the culprit afterwards. For example, one man complained of damage to his bamboo clump. The councillors gave orders that the depredations were to cease. But this proved of no avail; so they levied a fine of a pig on the unknown culprit, commandeered an animal and ate it. The villagers were informed that if they found the culprit he would be made to pay for it, otherwise the value of the pig would be added to the taxes. This had the effect of turning the whole village to detective work, and it was not long before the offender was brought to justice.

READY TO GO

Another view of an Ao warrior, this time clothed in full regalia for the war-path. Note the dao *which he is carrying*

With but few exceptions, every Naga village boasts of its *morung* or bachelors' house. This is the barracks or guard-house of the village in which the boys and unmarried men sleep and which the men use as their clubhouse. Boys enter the *morungs* when about ten years of age, and for the first three years act as "fags" for the older boys, becoming "bloods" at the end of that time as a new age-group of boys take their place. A boy remains in his age-group till he dies, and it is by this system of age-groups that various communal duties are carried out. The young bucks will be found toiling in the fields, doing the hardest work and taking the greatest risk. At the village gate there may be an old man weeding a little patch—the last member, perhaps, of his group. He is allotted the lightest task.

In some tribes both men and women resort to tattooing. Among the Aos, for example, the women are tattooed on the chin, throat, chest, arms and legs, the patterns differing according to the language, group or clan to which she belongs. The tattooing is done before marriage by an old woman skilled in the art, the required pattern being beaten into the skin with a little mallet of thorns.



A SEMA GIRL

Apart from the usual ornaments, she wears a band encircling her hair, showing that she is betrothed. Note the native-made cloth that she is wearing as a kilt

Generally speaking, girls marry between the ages of 14 and 18 and boys between 17 and 22. The marriage customs vary considerably in the different tribes. But a Naga either buys or works for his wife. In the former it may amount to so many baskets of rice, or a number of *daos* and other weapons; while in the latter case he works in the house or in the fields of his father-in-law for a stated period, generally a year. While, as a rule, Nagas have but one wife, wealthy men and chiefs in certain tribes have quite a large number, the *angs* having as many as 50 or 60. The chiefs of the Konyaks are regarded as sacred beings and wield immense power. A village may not shed the blood of its *ang*, however oppressive he may be; but cases are reported of the difficulty being overcome by throwing him over a cliff. A curious custom among the men of this tribe is to draw in the waist with cane belts.

A WEDDING DANCE

Among the savage tribes of the hinterland of Burma, dancing has been developed to a fine art. Here we have an example of it. The marriage customs are rather peculiar, in that the man buys his wife, or else works for her father for a certain period of time in order to pay for her. Generally speaking, the natives are monogamous, but the richer men and the chiefs occasionally have as many as 50 or 60 wives to support

THE staple food of these people is rice, to which chillies are added as a relish, as they like their curry hot. They also cultivate millet and "Job's tears" and rear and hunt cattle, as they are great meat-eaters. Woe betide the elephant or tiger that damages their crops for he is hunted remorselessly until he is killed, often with the most primitive of weapons. A Naga never drinks water if he can help it—always *madhu*, a kind of rice beer. If he goes down to the river to fish he takes his beer with him.

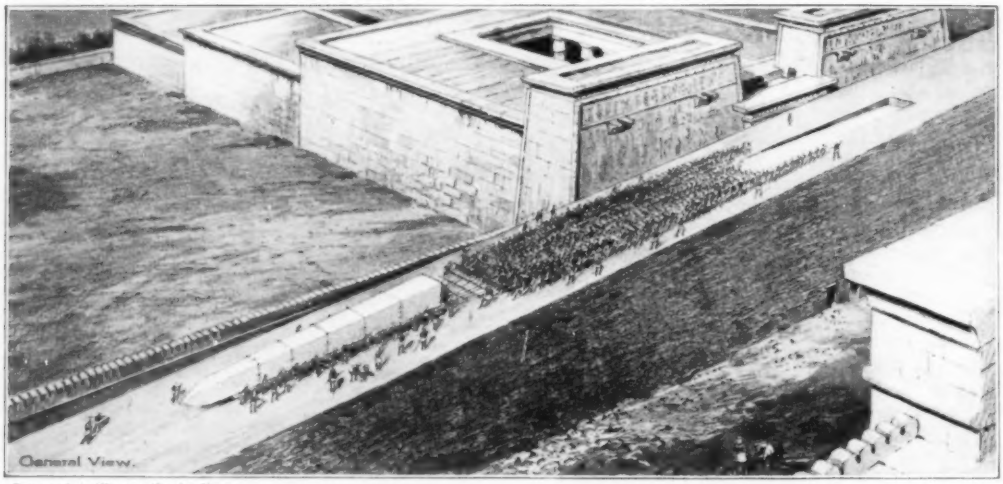
The American Baptists have a mission station in the Naga Hills and their great stumbling block in converting these people is over the question of prohibition. I heard of a Naga, a very fine type of fellow, who joined and rejoined the church six times in two years. He could not give up his *madhu*. Another endeavored to get over the difficulty by keeping up two establishments, on the plea that while residing in one he was at liberty to indulge in his old habits, but in the other he lived as a Christian.

The religion of the Nagas is animism, the worship of spirits. It is bound up with every act they do. The sowing and reaping of crops, the building of a house, the taking of a wife and many other acts are initiated by sacrifice, the smaller victims usually being chickens and the larger ones pigs. Apart from these sacrifices to spirits, feasts of merit are given; they are, as it were, ceremonial public banquets. It is the aim of rich men to perform the whole series, beginning with pigs and going on to cattle and *mithan*, or domesticated bison. He who has accomplished the full series may wear special ornaments, build his house in a particular way, and in some tribes set up a stone monolith.

To the ethnologist, the Nagas, with their strange manners and customs, and their no doubt close association by migration with the natives of Borneo and some of the South Sea islanders, present an intensely interesting study. As already stated, they are not only very warlike, but absolutely fearless, have a mania for taking heads, and firmly believe that the success of the harvest depends upon their offering up a human being. The latter is often a slave, of which there are hundreds in the unadministered areas. Hence the attempt by the Burmese Government to penetrate into these regions inhabited by the slave owners, and give the slaves their liberty by purchase.

A SOUTHERN SANGTAM COUPLE

In the background is their house. Parts of the country in which they live were hardly known to civilization ten years ago



Courtesy of the *Illustrated London News*

AN ANCIENT EGYPTIAN "90 HORSEPOWER TRACTOR"

Six hundred slaves hauling an obelisk up a ramp. From a purely technical point of view this "tractor" had a higher mechanical efficiency than the finest farm tractor, but the intelligence of the humans might well have been put to better uses

Muscles Built the Pyramids

Human Muscles are More Efficient than the Best Steam Engines. An Electrical Theory of Muscular Action

By DR. PAUL R. HEYL
Physicist, United States Bureau of Standards

"I'VE been spending the winter in Egypt," remarked one of a group of men in the smoking room of an Atlantic steamer. "Wonderful country—but its interest lies mainly in its past. The pyramids are marvels of ancient engineering."

"As an engineer by profession," said a second man, "I must protest that statement."

The other members of the group, who had given but languid attention to the conversation up to this time, showed signs of interest.

"We engineers," continued the speaker, seeing all eyes fixed inquiringly on him, "must justify the time and money spent on our training by doing things more expeditiously and economically than the untrained man. The French call us *ingénieurs*—"ingenious fellows." Now if there was anything really ingenious involved in the laying up of those masses of stone, I don't know of it. Those old fellows undoubtedly used the inclined plane to raise their blocks to position, but they are entitled to no particular credit for that. That device has been a matter of common knowledge ever since the first squirrel ran up a slanting tree."

"That's true," said the Egyptian tourist. "They didn't even use rollers. I saw one of their old pictures, showing a crowd of over a hundred slaves dragging a large stone statue mounted on a sledge. There was a man pouring something, probably oil or grease, on the ground in front of the sledge, and another man clapping his hands to mark time for the slaves to heave. And both these lazy beggars were riding on the sledge!"

"Yes," said the engineer. "That's exactly my point. The Pharaohs of that period had unlimited slave labor at their disposal. It was only a question of paying enough taskmasters and providing whips for them. The rest of the equipment was main strength and brute force."

"COULD you do the same work more efficiently today?" The question came from a man who had taken no part in the conversation before, and of whom little had been learned during the voyage, except that he was a physician. The engineer seemed rather irritated by the question and replied half contemptuously.

"Of course you know how such a job would be done now-a-days: a few portable steam engines with cranes and derricks, and those blocks would be slung into place in a jiffy. I don't know how long it took those old chaps to build one of those pyramids—the King's life-time, I've heard; but however long it took them, I'd take a contract to lay up the cut stone in less time with not over 50 men provided with modern facilities."

The tourist whistled softly.

"Better go a little slowly," said he. "At the Second Pyramid they showed us the workmen's barracks, still standing after 6000 years. They must have housed at least 4000 men."

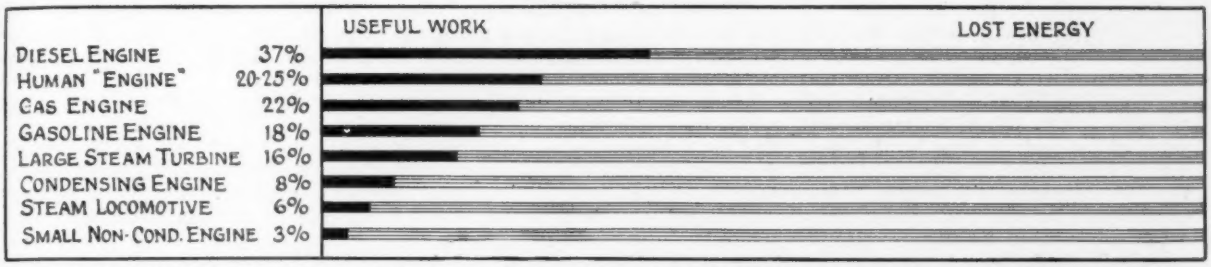
"Only 4000?" said the engineer. "Well, I suppose some allowance must be made for ancient brutality as against modern humanity. Today we'd hardly drive a man till he dropped. No, sir—we've made progress all along the line." And he glared rather defiantly at the doubting Thomas, who, after a brief pause, returned to the attack.

"Perhaps you, as an engineer, can tell us just what is the efficiency of a steam-engine?"

The engineer started to speak, but instead put his pipe in his mouth and puffed at it for some moments, eyeing the speaker thoughtfully. When he finally spoke it was in a tone of more respect than he had previously used.

"Well, these figures are things which we do not usually carry in our heads. We can always find them in the engineering handbooks. But I must say that the efficiency of a steam engine is not what we would like to have it."

"I happen to remember the figures," said the physician. "You will doubtless recall them. Taking the energy in the coal as a basis, the fraction of it converted into mechanical work may be anything from 5 to 20 percent. The non-condensing engines that dis-



WHERE DOES THE HUMAN "ENGINE" STAND WITH OTHER ENGINES IN MECHANICAL EFFICIENCY?

The human body is a more efficient engine than a steam turbine. What the non-human engine lacks is brains. These enable man to create engines which far excel his own body in total volume of energy. But until certain fundamental inventions had been made, brains counted for little

charge their steam into the air, such as portable engines and locomotives, give the lowest figures. Those engines that condense the exhaust steam and return the hot water to the boiler are the most efficient. But the most perfect engine in existence today wastes more than it produces."

"That is true," said the engineer. "But what about the human machine? We take in a certain number of calories in our food, just like the thermal units in the coal, and we convert some of it into work. I'll confess I don't know how much—but perhaps you do?"

"In this respect the performance of the human body exceeds that of the best compound condensing engine, and is comparable with that of the gas engine—from 20 to 25 percent efficiency."

The engineer whistled in his turn. After some time he said slowly and thoughtfully:

"Well, then—if old Pharaoh had freed his slaves—turned them loose to earn their own living, and had burned all the corn that he would otherwise have fed them, under the boilers of such engines as would be used today on outside work—he wouldn't have had fuel enough to finish the job!"

The physician shook his head.

"He would probably have had more than enough. We haven't all the packing out of the case. When the whistle blows for the day, the steam engine consumes no more fuel till the next morning; but the case is different with a man. He is like an engine with a low fire kept under its boiler all night and over all holidays. A man never stops working. During so-called 'working hours' he does only a little more than at other times. Even when he lies asleep his muscles of respiration are active and his heart-pump is going. In addition, his bodily temperature must be kept up. All this may require, in the 24 hours of the day, as much fuel as is utilized in the performance of what is usually called a day's labor."

"IT seems, then," said the engineer, smiling, "that simply on considerations of mechanical efficiency, old Pharaoh did better than we could do today, though he did take an intolerable time about it."

"Yes," said the physician. "The human body is a fairly efficient machine, though not very powerful."

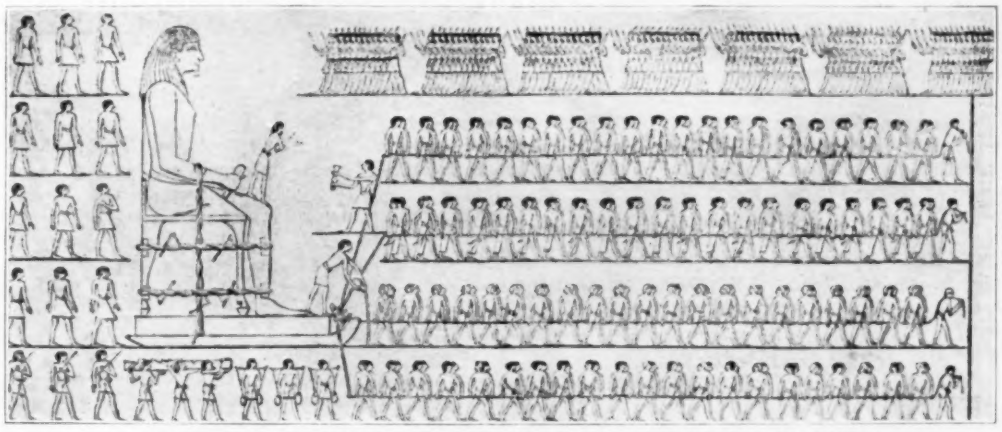
"There's something strange about that," said the engineer, after a pause. "A steam engine requires a boiler, and a condenser. In some cases the condenser is merely the open air. Between the boiler and the condenser there is usually a difference of temperature of a couple of hundred degrees Fahrenheit, and it is this difference of temperature that determines the efficiency of the engine. If we reduce it, the efficiency decreases; we therefore try to increase it as much as possible by using superheated steam in a high pressure boiler. But of course there can be nothing like that difference of temperature in the human body."

"No," said the physician. "A general increase or decrease of more than a very few degrees would soon be fatal; and any small portion of the body heated for any length of time to the boiling point of water would have its life destroyed."

"That's where the strange point comes in," went on the engineer. "With the greatest difference of temperature we can handle we cannot equal the efficiency reached by Nature, using no difference at all. And it's the only way we know of doing it. Are we on the wrong track? Why not imitate Nature's process?"

"Because we do not yet know enough about it. I agree with you that it would be worth while to imitate it. I would even go so far as to say that it is quite possible that we might improve on it. But we must know more about it first."

"But do you physicians know nothing about it?"



ANCIENT EGYPTIAN DEPICTION OF SLAVES HAULING A STATUE

At top, soldier guards. At left, reliefs of men. Lower left-hand corner, taskmasters. At their right, men carrying implements. Next, men carrying grease. On the sledge, man pouring out grease. And they didn't even use rollers!

"Very little, I regret to say."

"Tell us that little, doctor; don't be afraid to talk shop. This is getting interesting."

"Well, it will not take long to tell what we know. Since the mechanical work of the body is done by the muscles, it is in their ultimate structure that we naturally look for the answer to the puzzle. This ultimate structure is not hard to make out. A muscle is made up of thousands of tiny fibers, just as a hawser is made up of filaments that you might snap in your fingers. The little fibers making up a muscle may be an inch or so long and a few thousandths of an inch in diameter. Each fiber possesses the property of contracting when stimulated, and the sum of thousands of such feeble contractions makes up the force of the muscle."

"These fibers are something like rubber bands, I suppose," said the tourist.

"No, that is just what they are not. They are little bags containing a watery solution and some jelly-like material."

"That's curious," said the engineer. "Water is just about incompressible. That's why we use it in the hydraulic press. How can such a fiber contract?"

"It doesn't contract at all, in the sense of diminishing in volume. It shortens and thickens at the center, apparently trying to become globular; but this change of shape takes place without the slightest change in volume."

"Is there any known principle which would explain this action?"

"Yes, there is one—surface tension."

The tourist looked blank, but the engineer nodded.

"SURE enough—that would explain it. Just as a drop of water on a dusty floor takes a spherical shape instead of flattening out. You see," he continued, turning to the tourist, "every liquid acts as though it was encased in a stretched elastic skin, which is always trying to squeeze it into a spherical shape. If there is much liquid, its weight flattens it out, but if there is only a little the surface tension overpowers the weight, and we have a dew drop. But," he went on, addressing the physician, "what holds surface tension in abeyance in a relaxed muscle?"

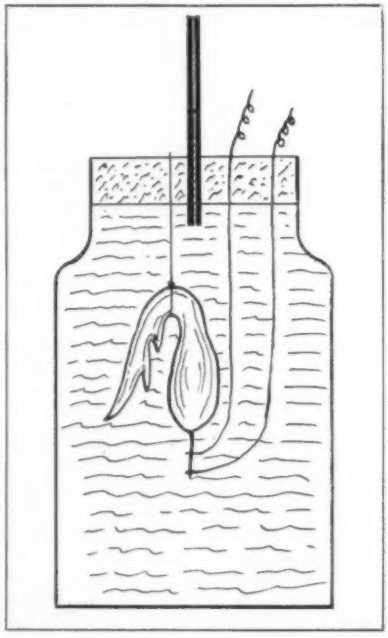
"It must be that the surface tension changes. It is known that muscular action is accompanied by a chemical change in the contents of the fiber. The process is probably like this: the relaxed muscle contains a solution with a weak surface tension. Upon nervous stimulation (don't ask me how) a chemical reaction is set up, and the resulting solution has a greater surface tension. In consequence, the fiber shortens and thickens."

"Then," said the engineer, "when the muscle relaxes, the reaction must reverse itself."

The physician nodded.

"But contraction is sometimes very rapid, and relaxation equally rapid. And, as I remember my chemistry, a reaction that takes place rapidly and easily is usually slow and difficult of reversal."

"That is the weak point of the theory," said the physician. "But we have nothing better to offer. It certainly appears that a change in surface tension must be the fundamental reason for the shortening of a



FROG'S LEG EXPERIMENT

The nerve is connected to wires, current contracts muscle, but water is not thereby raised in small tube at top; showing that muscle has not altered in volume

muscle; the absence of any change in volume points definitely that way."

"What else happens when a muscle contracts?" asked the engineer.

"A little heat is produced, and some electricity."

"Electricity? Are we built like the electric eels?"

"It seems so, to a slight extent, at any rate. Why not? All Nature is one."

"Is this electricity an after-effect?"

"No, it seems to occur simultaneously with the contraction, or even, as some have claimed, a minute fraction of a second earlier."

"When I was a boy," said the engineer, reflectively, "I once took hold of the handles of a medical battery—and I couldn't let go. They had to turn it off first. There was a case where the electric current not only accompanied muscular action but caused it."

"Yes," said the physician. "We commonly use electricity to stimulate muscular action in our laboratory experiments."

The engineer puffed silently at his pipe for a few moments.

"Look here," he said suddenly. "Aren't you doctors on the wrong track—haven't you got the cart before the horse?"

"How so?"

"This generation of electricity you speak of—what useful purpose does it serve?"

The physician shrugged his shoulders.

"No one knows."

"But it must play some important part in the action?"

'Yes," said the physician, thoughtful in his turn. "Otherwise it would be a waste—a mere gesture on Nature's part. And man is the product of so many ages of evolution and survival of the fittest that lost motion of this kind should have been pretty well eliminated. But what's your idea?"

"SIMPLY this: the electric current is the real reason why the muscle contracts; and it relaxes when the electricity is turned off."

The physician in his turn looked keenly at the engineer.

"In that case, electricity should produce a change in the surface tension of a liquid conductor."

"Yes," said the engineer. "It does. The fact was discovered by Faraday."

This was evidently a new idea to the physician. He was silent for a few moments. Then he said:

"According to your idea, the muscular contraction should be proportional to the strength of the current applied to it?"

The engineer nodded.

"Well," said the physician, "experiment does not support that. It seems clearly made out that a muscle fiber indulges in no halfway measures. Either it contracts to its full extent or not at all. We call this the 'all-or-none' law."

"But certainly a muscle can act by intermediate stages?"

"We explain that by supposing that only a part of the fibers are stimulated."

"But why not suppose that only part of the fibers are affected by the current? Isn't it as broad as it is long?"

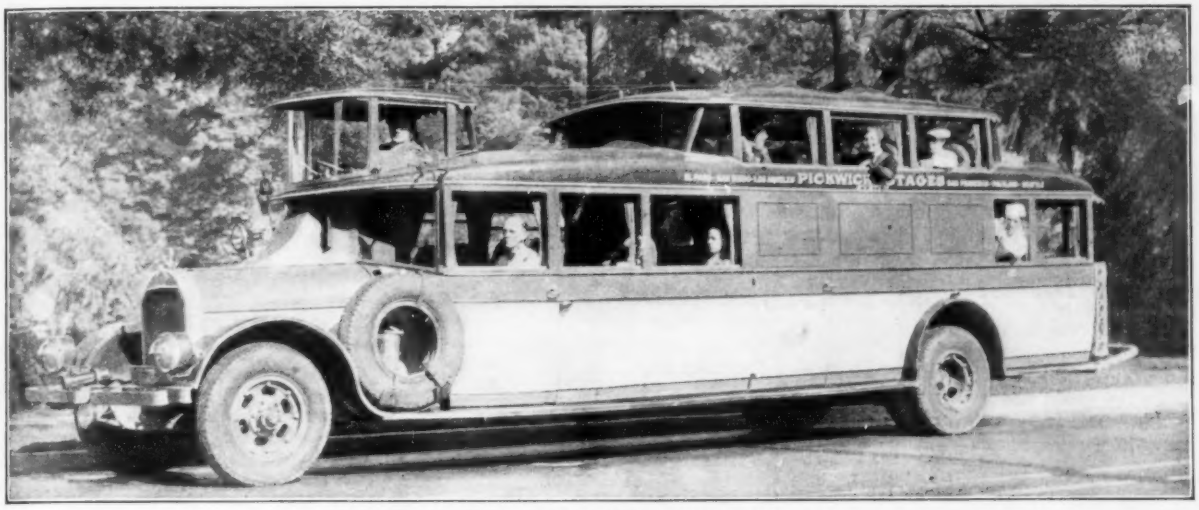
The physician admitted that it was.

"Well," said the engineer, glancing at the clock and rising, "it's nearly time for lunch. I'm indebted to you for a pleasant and interesting morning, doctor. I expected to be horribly bored, as is usual when one is on these voyages."

"Yes," said the physician, with a twinkle in his eye. "I think we have both learned the advantage of looking at our own work through another's eyes."

Motor-bus Transportation De Luxe

Luxurious Appointments Contribute to Traveler's Comfort



THE BUS AS IT APPEARS ON THE HIGHWAY

With its long wheel base, large pneumatic tires (double ones on the rear wheels), and heavily upholstered seats, this newly designed addition to a western transportation system presents solid comfort to the traveling public which uses the bus

THE "PILOT HOUSE"

So that he may have a full view of the road, even in heavy traffic, the bus driver is located in an elevated glass enclosure

THE RADIO EQUIPMENT

Built into the side of the bus is a complete radio receiver. The cone type loudspeakers are located in the ceiling of the body

LUNCH IS SERVED

Part of the equipment of this new bus is a complete "galley" from which meals are served. Notice the grill-work in the ceiling. This covers the cone type of loudspeaker used with the radio set. The latter is installed in the side of the bus

TRAVELERS from Los Angeles to San Francisco may now go by motor bus, and still have all of the comforts of the ultra-modern railroad train, with possibly a few others added. The upper illustration on this page shows a side view of one of the new busses that makes the trip. One of the most unique features, at first glance, is the position of the driver. His seat is elevated and the enclosure that protects him from the elements has glass on all sides. Thus he has clear vision to all points, and being elevated, can watch other cars and exercise more care and judgment when in traffic. Within the bus, every desire of the traveler has been taken into account. Lunches may be obtained from the buffet, and the radio may be turned on when entertainment is desired. There are two decks on the bus, seats on either one affording the passengers ample view of the surrounding country. It is busses of this kind that should contribute largely to the opening to the public of territory in the west that is not efficiently served by rail. Busses that are safe, comfortable and fast will naturally tend to draw rapidly increasing patronage to them.

OUR POINT OF VIEW

NAVY DAY

NAVY DAY was instituted for the purpose of bringing before the American people the importance of the United States Navy as the first line of defense of their country. One of the outstanding facts of United States history is that whenever war has come upon us, the American people have been quick, though late, to realize the vital importance of a navy in our scheme of defense, and that, as soon as the war was over, the great lesson has been forgotten, and the navy has suffered neglect and fallen to a very low level of strength and efficiency. This happened after the War of the Revolution, after the War of 1812, and notably after the great Civil War.

The vital importance of a powerful navy in a war waged against an enemy possessing an extended coastline, was never more clearly emphasized than in the Civil War; for it was only when the hastily built fleet of the Federal Government became powerful enough to enforce an absolute blockade of the Southern states, that the Northern armies were able to crush the heroic resistance of the enemy. But apparently the lesson thus taught was quickly forgotten. The great fleet was quickly demobilized; no effort was made to keep abreast of modern naval development; and our navy sank to such a low ebb that 20 years later, our flag was represented on the seven seas by a mere handful of old and rapidly deteriorating wooden ships.

It seems to have been overlooked that the Washington Treaty of Limitation has effectually prevented any such neglect; for by that treaty we are held up to a parity with the British fleet. As matters now stand, the prevention of any such deterioration of our navy as occurred after previous wars depends upon the willingness of the American people and their Congress to maintain our navy in the front rank assigned to it by the Washington Congress.

If the country thus does its duty by the navy, the only way in which we could lose our position would be by the determination of Great Britain to break away from the treaty and build up her fleet independently of treaty requirements. But at the late Geneva conference British representatives reiterated over and over again their wish to abide by the treaty and maintain their fleet only at parity with our own.

MERCHANT MARINE AND THE NAVY

FEW people realize that the defense of our coast-wise, sea-going commerce is fully as big a problem as the protection of our sea-borne commerce with foreign nations. So much attention has been directed to the latter problem that the importance of protecting coast-line shipping is in danger of being overlooked. It will be a surprise to many to learn that the ocean-going, coast-wise trade of the United States is of equal size and value to the entire ocean-borne foreign commerce of the country in ordinary years.

Our freight carried by ocean coast-wise shipping in 1925, excluding Great Lakes traffic, amounted to over 91,000,000 tons, whereas our ocean-going foreign trade in the same year was less than 90,000,000 tons. This important trade, moreover, is so vast that no considerable part of it could be taken over by the railroads during a war.

Destroying Faith in Aviation

BEFORE people will take to the air in sufficient numbers to render commercial aviation successful, they must be convinced that air travel is safe. This is an absolutely fundamental condition. Hence the recent epidemic of ocean flights with its loss of over two score lives and a dozen machines, has struck a sad blow at commercial aviation. The flight of Lindbergh gave a wonderful impetus to the art, the effect of which has been sadly blighted by the hasty ventures of the courageous fliers who have vanished over oceans. Says Colonel Lindbergh: "Regular trans-oceanic travel by air is no more practical today than transcontinental air lines were a decade and a half ago. . . . .The pioneering is over, but the perfecting is yet to be done."

Our rail transportation facilities were taxed to capacity during the World War, which hardly inconvenienced coastwise shipping. Since the war, the population of the United States has increased 10 percent, whereas our railroad mileage has increased not at all. The enlarged freight and passenger traffic of the past ten years has been absorbed by the greater efficiency in the operation of our railroads and by motor transportation. These agencies, however, could not assume, in an emergency, an additional burden of 90,000,000 tons of long-haul freight. Evidently an efficient navy is necessary to insure the uninterrupted flow of this coast-wise trade, to say nothing of its other multifarious duties throughout the seven seas. Regarded in this light, the navy may be looked upon as an insurance of one of the greatest arteries through which the lifeblood of our vast industrial and commercial interests flows.

GOOD FOR FIFTY YEARS

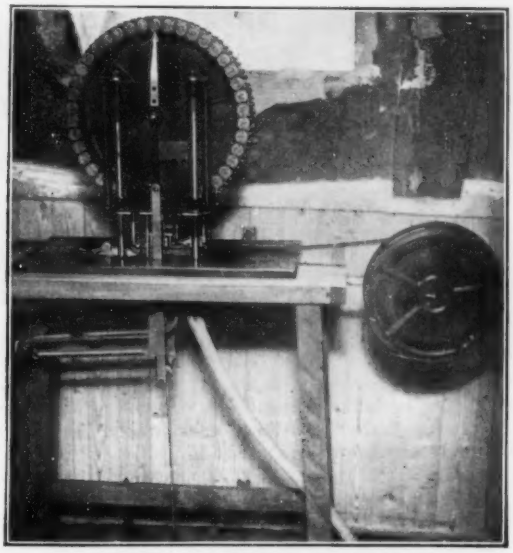
VERY subtle is the technique of the propagandist. More often than not he seeks to gain his point by devious ways. Thus, the advocates of the construction of an American deep-sea canal at Nicaragua are endeavoring to pave the way by representing that the Panama Canal is approaching the limit of its capacity. John F. Stephens, the distinguished engineer who preceded Colonel Goethals at Panama and organized the methods of excavation which effectually hastened the completion of the work, recently dealt a death blow to this propaganda at an address delivered at the Annual Convention of the American Society of Civil Engineers.

He proved by unanswerable statistics that, after future enlargements, the canal will "have ample capacity for all transits for the next 50 years and perhaps longer." Here are the figures: Although the canal is operated only during daylight hours; on January 17, 1924, a total of 57 vessels made the transit. The Soo Canal, which is closed for four months in the winter, passed in 1926, an average of 90 vessels per day. If these locks should work the entire year they would pass 32,860 vessels, or about 134,000,000 tons. The Panama Canal passed 26,836,241 tons in 1926. Since the Soo Canal could pass 100,000,000 tons yearly, if not ice-bound for four and one half months. what could the Panama Canal, with practically the same facilities as the Soo, pass in twelve uninterrupted months of operation? The maximum number of transits at Panama in one month was 611 ships in March, 1927. This represents an average of 19.7 per day, which is not over 40 percent of its capacity.

With wise provision for the future, the locks at Panama were so located and built that, when the need arises, a third set of locks can readily be added alongside the present locks. Nor need there be any anxiety as to future water supply, which can be greatly increased by the construction of a large dam at Alhajuela, a few miles above the point at which the Chagres River enters Gatun Lake. With the new locks added whenever they become necessary, and with day-and-night-operation, which is perfectly feasible, the Panama Canal, so far as human foresight can determine, will serve its purpose adequately for another half century.

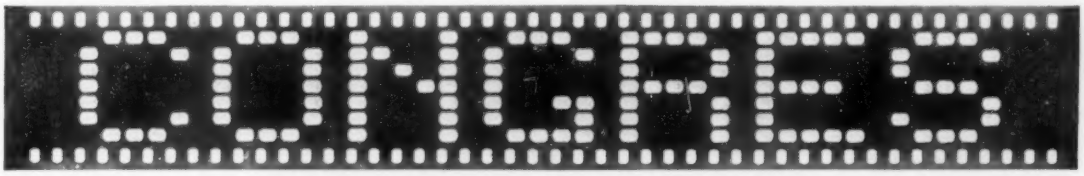
AS THE CAMERA SEES THE SIGN

The "talking sign" as it appears to the camera presents a solid band of illumination, because several words have passed during the exposure of the negative



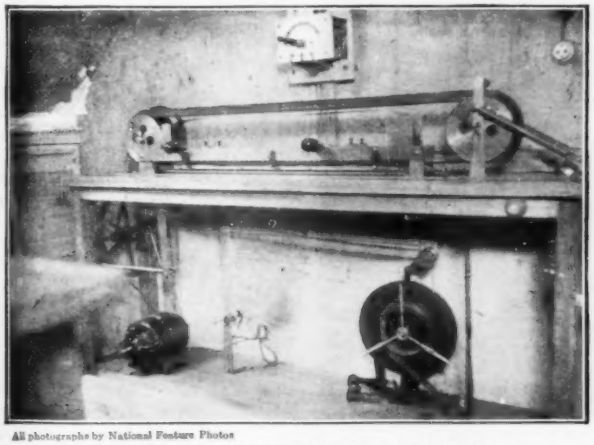
THE PERFORATING APPARATUS

Here the paper tape is passed through a machine where it is punched with various letters as is illustrated below



A SECTION OF THE PERFORATED PAPER TAPE

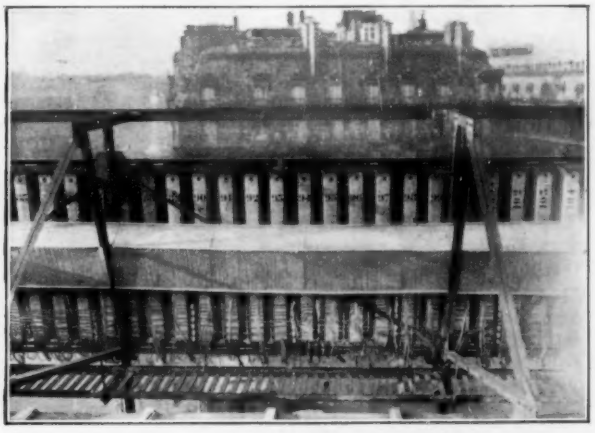
The descriptions of various news events are punched in the tape as they are received from telegraph messages from various parts of the world. The tape is perforated at the edges in a manner similar to motion-picture film so that it can be fed smoothly



All photographs by National Feature Photos

WHERE THE CONTACTS ARE MADE

At this point the paper tape passes between spring brushes and a metallic surface. Contact is made when the holes pass between



THE ENORMOUS BANK OF LAMPS

The electric light bulbs in the housings shown are controlled through wires by the interrupting action of the perforated paper tape

World Events From Flashing Sign

IN many of the larger cities throughout this country, the inhabitants are familiar with the advertising signs that transmit their messages to the public by means of illuminated letters which seem to pass slowly from one end of the sign to the other, being followed by others, which are so spaced that words and phrases are spelled out. There are now two newspapers in France that use a similar but improved sign for transmitting to the public the latest bulletins from the world. The mechanism that is used in these signs is illustrated above. A special machine is used to perforate a paper tape. The operator of this machine receives his information from cables and telegraph lines and at once translates it to the tape. This tape then is run through a circuit breaker, opening and closing contacts which correspond in spacing to the shapes of the letters. In this way banks of lamps are illuminated, and as the tape passes along, the effect as seen on the sign is that the lamps forming the letters move.

"How Do They Know?"

When Astronomers Talk of Galaxies of Stars 60,000,000,000,000,000,000 or More Miles Distant, How Have They Arrived at Such Stupendous Figures?

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory, Princeton University
Research Associate of the Mt. Wilson Observatory of the Carnegie Institution of Washington

As the nights lengthen and the winter constellations advance into view, the greatest of the nebulae—that of Andromeda—comes into sight. Almost every star gazer knows how to find it—follow the line of stars which runs eastward and northward from the great square of Pegasus, turn off to the northward at the first large star in the line, pass two fainter stars and the hazy, oval mass of light is easily visible to the unaided eye, and conspicuous in a field glass.

We all know, too, how photographs show that the visible portion of the nebula is but the central and brighter region of a vast spiral mass of faint light whose extreme diameter is almost three degrees or six times the apparent size of the moon. The story has been told, too, in these columns how the outer parts of the nebula have been resolved, on Hubble's photographs, into countless thousands of tiny stars, and how, by the discovery of variable stars among them it has become possible to find the distance and size of the whole stupendous system.

Photo by Yerkes Observatory

GREAT NEBULA IN ANDROMEDA

Only the central part shows to the naked eye. The small nebula directly above the center, in the photograph, is a companion to it

HUBBLE'S latest data makes the distance 870,000 light-years, and the extreme diameter 45,000 light-years. Until within comparatively few years ago it was supposed that the whole universe of stars was not nearly as big as this.

Now the Andromeda nebula is by no means a unique object except in its apparent size and brightness. There are hundreds and probably many thousands of spiral nebulae in the sky, similar in general appearance but fainter and smaller. Do they look so because they are really smaller and less luminous, or only because they are farther away? This is not an easy question to answer in the present state of our knowledge; but Hubble has given good reasons for believing that the second of the two explanations is in the main the true one.

To begin with, there are six other nebulae whose distances can be directly measured or estimated by the same methods. Two of these are the great Megallanic Clouds of the southern hemisphere which, if more remote, would appear as nebulae of regular form. Their distances according to Shapley are 112,000 and 104,000 light-years. Among the spiral nebulae Messier 33, which comes next to that in Andromeda in size and brightness, has been resolved and is full of variable stars. Hubble finds its distance to be very nearly the same as that of the Andromeda nebula. Another spiral, Messier 101, shows fainter variables, and Hubble's estimate of its distance is 1,500,000 light-years. [A light-year is, roughly, six trillion miles.—EDITOR.]

There is another nebula, oval, bright and relatively small, and known as Messier 32, which is close to the great Andromeda nebula in the sky and shows the same radial velocity of 300 kilometers a second. Like its greater neighbor and unlike almost all extra-galactic nebulae it is approaching us. This makes it decidedly probable that the two nebulae are really neighbors and that the distance of the smaller one is in round numbers 900,000 light-years.

Given these distances and knowing the apparent brightness—which has been carefully determined for a large number of nebulae by the Austrian astronomer Holetschek—the real brightness can be calculated. The resulting absolute magnitudes range from minus 17.1 for the Andromeda nebula to minus 13.3 for its companion. That is, the actual light emission for the first is 580,000,000 times the sun's light, and from the second 18,000,000. These values are entirely consistent with the other evidence which indicates that these nebulae are vast clusters of millions and perhaps hundreds of millions of stars. These two nebulae differ a good deal in brightness—one is about thirty times as bright as the other—but they represent the extreme range so far observed. For the seven nebulae of known distance, the mean absolute magnitude is minus 15.1, corresponding to a light 90,000,000 times the sun's.

SUPPOSE we should say that in round numbers a nebula of the sort is 100,000,000 times as bright as the sun, and use this rough value to work out the distances from the observed brightness. For the Andromeda nebula we would get a little less than half the true distance; for the companion rather more than twice too much. For the other five nebulae we would be nearly right. This may not sound very good, but if we previously knew nothing about these distances, a method which, although it gave only rough values, gave us results which were not more than twice too big or too small, would be exceedingly welcome.

But can we trust this estimate to hold good for the other nebulae whose distances cannot be got at directly? What have we to guide us? To begin

with, there are a good many more nebulae (always of the extra-galactic type) in which individual stars can be photographed—as can be done for six of the seven nebulae of known distance (all but M 32). For these six the real brightness of the brighter constituent stars can be found. The absolute magnitudes range from minus 5.5 to minus 8, that is, from 18,000 to 180,000. The brightest stars in the various nebulae are therefore roughly alike in brightness. Their average absolute magnitude, minus 6.4, corresponds to about 40,000 times the sun's light, and the assumption that this was true in each individual nebula would give us estimated distances were quite as good as the first ones.

NOW Hubble has tested 15 other nebulae in which stars are shown. As might be expected, these nebulae are fainter than the first seven, and so are the stars within them. Estimating their distances on the basis that these stars are 400,000 times as bright as the sun, values are found which range from 2,000,000 to 4,500,000 light-years. Now when with these distances we calculate back to the total brightness of each nebula, we find an average value agreeing very closely with out original estimate of 100,000,000 times the sun's light, and fully confirming it.

This is important; for we know no reason why an isolated star cloud should be large or small, bright or faint (although some day we may be wiser). But we are in possession of a sound physical theory of the brightness of the stars, and there is good reason to suppose that what holds true of them, on the average in one star cloud, will also hold approximately true in any other. However, the argument based on the brightness of individual stars deserves to be taken very seriously, and the conclusion that on the average the great extra-galactic nebulae are a hundred million times as bright as the sun is much strengthened by it.

Photo by Mt. Wilson Observatory

A SPIRAL—SIDEWISE VIEW

The great nebula N. G. C. 4565 in Coma Berenices is edgewise to our point of view

One more bit of evidence, applicable to a still greater number of nebulae, comes from Hubble's work. The apparent diameters of the nebulae are closely related to their apparent brightness. Taking, for example, those which appear as hazy, circular objects with outspread arms, he finds that if they could all be moved to such distances that they appeared equally bright they would all look about equally big. For those which are oval in form the same thing is true: but, for the same brightness they would appear bigger than the round nebulae.

The spirals, if brought again to such distances as to appear as bright as the rest, would be of still larger diameter. But all the nebulae of each class—round, oval, closely wound spiral or open spiral—would be much alike in apparent size.

Photo by Mt. Wilson Observatory

ANOTHER GREAT SPIRAL

This is M33 in the constellation Triangulum. Note its "pin-wheel" appearance

This is obviously what would happen if the nebulae of a given form were really not only of about the same brightness but also of the same actual size. But by itself it does not prove that the inference is true; for it may be that the fainter nebulae are also smaller—provided that in some way the unknown laws which govern their constitution make their diameters proportional to the square root of the amounts of light which they give out into space.

In view, however, of the direct evidence that twenty or so of the most prominent nebulae are fairly similar in their real brightness, it is reasonable to suppose that the same rule holds for the rest. From this, Hubble figures that a round nebula of the extra-galactic type is about 1000 light-years in diameter (since the light of such a body fades off very gradually at the edge, no exact value can be given). A roughly oval nebula without spiral arms may have a long diameter of as much as 3500 light-years, its shorter diameter being again about 1000. The most widely expanded spirals are, on the average, about 10,000 light-years across and, like the others, 1000 light-years thick at the center where, as is clearly shown in the example reproduced in the illustration at the bottom of this page, they bulge out the most.

Photo by Mt. Wilson Observatory

SPIRAL NEBULA M101

To photograph this distant galaxy required seven hours with a 60-inch mirror

Individual objects like the Andromeda nebula are doubtless considerably larger, and others may be correspondingly smaller. But it appears very probable on the existing evidence that the figures given above for the size and brightness of these nebulae are good enough averages to give us a reliable idea of the distances at which the fainter and more remote of the nebulae lie.

THE faintest nebulae which can be seen with small telescopes are of about the 12th magnitude. If they, like the others, are a hundred million times as bright as the sun, their distances must be of the order of ten million light-years.

With the 100-inch telescope and long exposures under good conditions, it should be possible to distinguish the image of a nebula as faint as the 18th magnitude, from that of a star, and thus to reach objects at the distance of 140 million light-years. Nebulae twice as far away might be photographed, but could not be distinguished from faint stars unless and until a larger telescope than we now possess is provided.

It is therefore not only possible but probable that our great telescopes enable us to observe celestial bodies so remote that the light by which we study them has been upon its way since remote geologic times when the whole face of the earth was different, and reptiles such as the great dinosaurs, not man, were the dominant inhabitants of our planet.

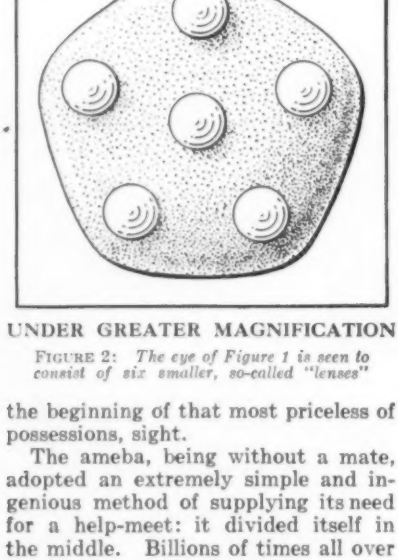
Evolution of the Human Eye

Will Man Eventually Lose One Eye? A Cyclopean Race is Predicted by One Scientist

By W. E. BAILEY

VAST ages ago, probably in some wind-swept, wave-tossed sea, a tiny bit of protoplasm or living cell appeared for the first time on this planet. That is the belief of science. Why this microscopic Adam should thus put in an appearance, and by what process, are mysteries today, although men of science are determined that the riddle must be solved. But they do know, and can assert it with the assurance that all who have eyes will agree, that at some time the process had to start.

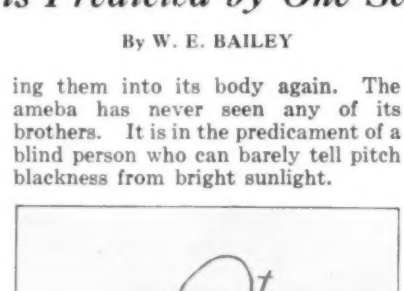
No one has ever seen that protoplasmic Adam, but there are many who have seen a tiny animal which must be very much like him—our much-discussed little friend, the ameba. The study of this speck of life has resulted in information which throws light on the riddle of our own existence. Not the least interesting thing about the ameba is the fact that although it has no eyes, it is all eyes, being light-sensitive throughout its whole body. Here, then, we must be quite close to the beginning of that most priceless of possessions, sight.



UNDER GREATER MAGNIFICATION

FIGURE 2: *The eye of Figure 1 is seen to consist of six smaller, so-called "lenses"*

The ameba, being without a mate, adopted an extremely simple and ingenious method of supplying its need for a help-meet: it divided itself in the middle. Billions of times all over the world every day it is still propagating itself in this manner. And not only does it keep its sight, but it passes it on each time it produces this duplicate of itself. It has the property, too, of growing an arm or a leg at will, and, more amazing still, if it wishes, it can lop them off merely by absorbing them into its body again. The ameba has never seen any of its brothers. It is in the predicament of a blind person who can barely tell pitch blackness from bright sunlight.



THE SIMPLEST EYE

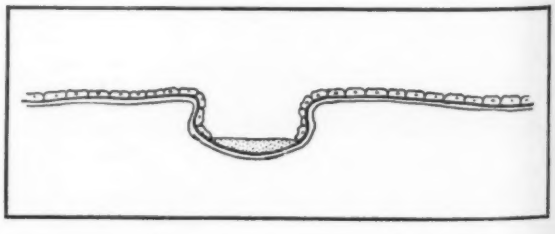
FIGURE 1: *Euglena and its eye, under low magnification. The spot e is the eye*

A little farther down—or up, if you prefer—in the scale of life, one might expect to find other simple forms of eyes. Since the amebas kept their eyesight all down through geologic times it is obvious that they used it; and because nature's method has long since been shown to be one of trial and error, and the ultimate a survival of the fittest, students of this fascinating subject concluded that something must have happened when the ameba discovered it could not utilize its light-sensitive body to see food.

One of these delvers into the secrets which are bound up into that marvellous mechanism we call an "eye," Dr. Thomas Hall Shastid, ophthalmologist of St. Luke's Hospital at Duluth, Minnesota, believes he has found the animal which possesses the first specialized eye. This animal, the *Euglena viridis*, a closely related member of the same group of animals, the protozoa, is on the border line between the microscopic and the macroscopic—the invisible and the visible—worlds, and its eye, Figure 1, is a tiny rose-colored spot (*e*) just below its mouth (*g*).

Although the *Euglena* has never seen a sunset, its eye is decidedly useful. To it the *Euglena* owes its hold on life. Dr. Shastid constructed a box containing three compartments, one brightly lighted, one dimly, and one in darkness. Pouring ooze and water over the floor of all three, he turned *Euglena* loose into the dark compartment. In a short time it was found in the dimly-lighted cell. If placed in the brightly-lighted division it likewise was shortly to be found in the dimly-lighted cell; but if placed in the subdued light it stayed there. Its eyes have the ability to determine what conditions are best, and, obeying them, it is safer than we are when trusting to our eyes as we cross a busy street.

BUT while *Euglena viridis* has what seems to be an extremely simple eye, under high-power magnification, Figure 2, one can see what appear to be six lenses. Science does not agree on the function of these structures; in fact no adequate theory to explain observed data has hitherto been worked out, and this has for many persons been a stumbling block in the acceptance of the evolutionary theory in general. Dr. Shastid is of the opinion that the so-called lenses of the *Euglena* are not true lenses at all, but are the ancestors of the rods and cones of the human retina. At all events, the eye of *Euglena*—the word, from the Greek, means "good pupil"—is not by any means a pupil, because a pupil is not a thing but a hole in a thing, and *Euglena's* eye is a substance, a bit of



CROSS SECTION OF PIT EYE

FIGURE 3: *The light-sensitive pigment is placed for protection at bottom of a pit. This pit forms the beginning of the ball of the subsequent evolution of higher types of eyes*

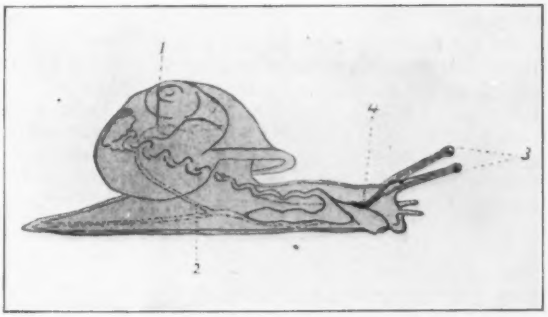
pigment. It is, in fact, the ancestor of the pigment epithelium layer of our retinas and, in addition, of the pigment in our skins.

This does not imply, of course, that man is the descendent of any of the living protozoans, any more than he could be the descendent of any of the living apes. It is, however, believed that man and possibly all the existing forms of life descended from animals which were not very different from certain protozoans that are living today much as they must have lived a thousand million years ago. In other words, this hypothesis implies that not every individual of every form of life has been subject to conditions that caused it to evolve. This explains the existence in our times of animals that have come down from ancient geological times relatively unaffected by evolution.

The eye of the *Euglena* being constantly subject to injuries, nature seemed to say: "I can surely beat that." So, in slightly higher animals, she made a depression and set the eye down in it, Figure 3. This structure may be seen today in some of the worms, such as the *Capitellidae*. It appears to exist solely for the protection of the eye pigment, and Dr. Shastid's painstaking researches have convinced him that it is plainly the forerunner or ancestor of the globe of the human eye.

BUT in setting the light-sensitive pigment in a depression, nature had overlooked the possibility that sand and foreign particles could still enter the eye. So, discovering her mistake, nature filled the pit with a viscous, transparent substance which could not flow out of the pit, this material being the ancestor of man's aqueous and vitreous humors. No image of an object could be formed through such an eye, but it was probably because this method did not furnish full protection to the eye that nature grew a shoot of integument across the pit, forming the first cornea. These corneas were probably opaque at first, as in some types of snails today. In some species of snails the closing membrane has not yet quite crossed over.

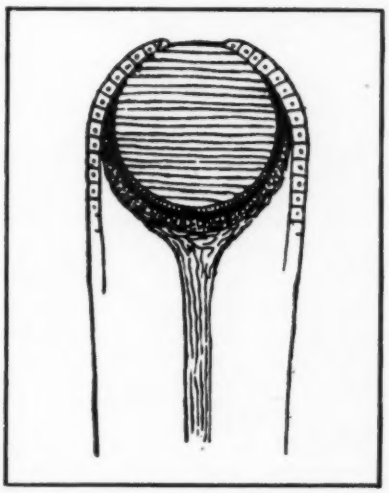
And, because some of these corneas were more efficient than others, due to being thicker in the middle than at the edges, the animals so favored multiplied faster because of a decided advantage over the others in the struggle for existence. Thus came about the development of lenses in the eye.



ORDINARY SNAIL

The eyes are placed at the end of the retractile eye-stalks or ommatophores. The tip of one of these eye stalks is shown in the sketch below, where the shoot of the opaque integument (primitive cornea?) can be seen partly covering the front of the eye

What other connections there are between the eyes of the invertebrates and the eyes of humans it is difficult to say, for, as Dr. Shastid carefully points out, as one passes over to the vertebrates, and specifically to the fishes, the subject of eye development becomes one of great obscurity; but it is no greater than that which surrounds the pedigree of man in general. As one scientist put it, "We do not know, after more than a century of morphologic study, even whether man and the other vertebrates have descended from a segmented, or an unsegmented, ancestor." That is to say, in a manner of speaking, we do not know whether man came up the trunk of the tree or through the branches!



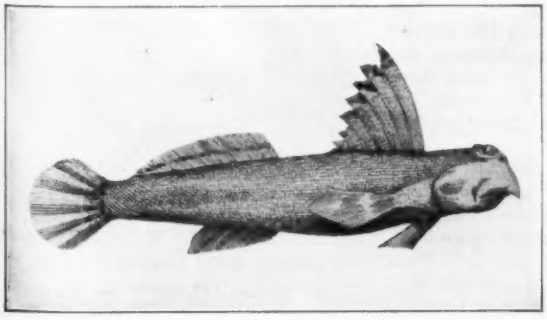
THE EYE OF THE SNAIL

Magnified and in longitudinal cross-section. There is no lens in this eye

Besides having given us backbones, the fish first introduced a true crystalline lens. Fishes also introduced true focusing arrangements, the iris and the pupil, and extrinsic eye muscles; and they almost succeeded in introducing eyelids. Flies, by way of contrast, with their simple and compound eyes, have no need for a focusing apparatus, because their three simple eyes for near objects, and their compound eyes for distances of three or four yards, supply the lack of it. And the wide field of view of the compound eyes obviates the necessity of other than a motionless, jewel-like setting in the head.

BECAUSE no organ can function efficiently without periods of rest, nature devised sleep. In the case of vertebrate eyes, because of their delicate organization, other means were necessary in addition, one of these being "motion-blindness" or the inability of the eye to perceive objects while the eye is in motion. The other expedient of major importance is retinal rest, due to eyelids. In a few species of fish are found fixed dermal folds both above and below the eye; in some sharks there is an eyelid in the inner corner of the eye, and a similar lid is found in snakes and birds. There is still a vestige of this fold in the human eye, but the functioning eyelids of man came from the upper and lower eyelids which were started by his distant ancestor, the fish.

Some of the fishes developed lungs, and, finding that they could breathe in the air too, they flopped out on the land. Thus originated the amphibians, animals able to live both in water and on land. Their pectoral fins became shoulders and arms, their ventral fins were slowly changed into hips and legs. The radical changes brought about in their living conditions required a readjustment; but that the transition is not yet complete is evidenced by the fact that every embryo child has gills at a certain



WALKING FISH

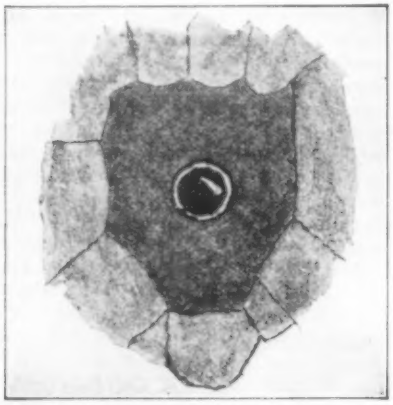
Periophthalmus, a sea fish that goes ashore and walks around on its pectoral fins. From a geologically ancient type of fish which gradually acquired this habit all the existing land animals, including man, are believed to have descended, as is explained in any textbook or general treatise on evolution

stage of its early foetal development.

In the depths of the sea fish found that their sight apparatus was quite sufficient. But, exposed to bright lights and to the struggle for self-preservation, new devices were necessary to render the eyes capable of adequate service. Nature therefore contrived to protect the eyes of fishes against the terrific strain now put upon them; and the result was eyelids. The amphibians developed eyelids from the meager beginning made by the fishes, and particularly the lower eyelid. In fact, the frog developed his to the extent that he winks his lower lid upward, whereas the human winks his upper lid downward.

NO fish ever shed any tears because of the sympathy freely poured upon him. It was the amphibians who presented the world with weeping facilities: lachrymal secretion and drainage. The snakes, belonging to the family of reptiles, made little contribution to eyes, although they have both an upper and a lower eyelid. Their eyelids are chiefly to protect their eyes against scratches as they glide past sharp sand, briars and thorns. These eyelids, however, are fused together, and transparent, except at shedding time when they become opaque. This provides an explanation for the periodic blindness to which snakes, as every farmer knows, are subject.

From the hideous reptiles branched off both the mammals (animals which

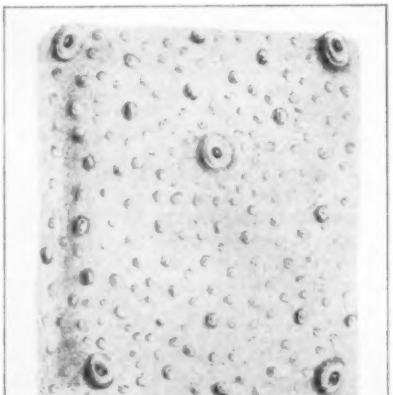


THIRD EYE OF LIZARD

Man's skull conceals the vestige of an ancestral third eye, the hidden pineal gland

suckle their young) and the birds. But which of these two came first is not known. At all events the primates (the highest division of the mammals) possess pupils which are round. The primates developed stereoscopic vision, which is vision of the same object through both eyes at the same time. In monkeys, stereoscopic vision can be obtained but not long held; in the apes this type of vision comes much more easily; but only in man is there continuous, readily maintained stereoscopic vision—although in children the eyes do not as a rule move in perfect unison until about three months after birth.

Because of the development of a speech center in man, there has come about what is called dominancy and



LIGHT-SENSITIVE SKIN

To escape from the Periophthalmus, the Onchidium has developed eyes on its back

serviency in human eyes, a phenomenon not found in the other mammals. This means that, in the human, the brain does most of the seeing through one eye, even when both eyes are open. Dr. Shastid has found that from 95 to 100 percent of the detail of any object comes through the right eye if the person be right-handed; while if the person be left-handed the left eye as a rule, but not always, takes up the major part of the detail. This condition, which he has been unable to observe in any other animal, may eventually result in consequences of vast importance to humanity. But let Dr. Shastid tell it:

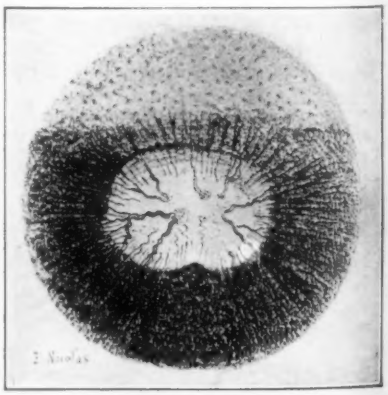
"IN the course of generations, man's 'field' of view will become smaller and smaller. This, because his need of a wide field is growing less and less. This I say with full realization that we live in an age of automobiles, and that these vehicles render desirable a wide field of view. The automobile is probably a very transitory phenomenon. I even believe that, in the course of countless ages, the two human eyes will come closer and closer together, the bridge of the nose will further diminish and sink (just as the animal snout, in man's line of descent, has been doing for vast aeons of time) and, finally, man's two eyes will again become one—just one large, central, cyclopean eye.

"It is likely that the merely servient (left) eye will shrink away (as the pineal eye has already done) so that the right eye will become the cyclopean. Certain it is that the left eye, even today, is being used less and less continually. Man's binocular and stereoscopic visions are being destroyed. That is the price he pays for his speech center.

"The great cyclopean eye, however, will regain stereoscopic vision by developing two maculae in the one eye, just in the fashion in which many birds have stereoscopic vision in each eye now. Although the field of view will then be narrower than now, the eye will probably be microscopic and telescopic; it will be exceedingly acute for colors, for motion, and for form; and, finally, most important of all, it will probably be able to perceive as light many forms of energy which now produce in human eyes no sort or kind of perception.

"EVOLUTION of the fleshly eye has been, for man, in the more recent stages of his progress, much too slow. So man invented the microscope, the telescope, the spectroscope, and even the X-ray apparatus which permits him to see through opaque objects. Nature, seeking valiantly to help man's eyes adjust themselves to the new set of conditions wherein man reads, writes, repairs watches, cuts gems, examines pictures and so on, has done so in two different ways—one bad, one good. The bad way has been by making him near-sighted. The near-sighted eye, at rest when looking at near objects, is always a diseased eye. But the normal-sighted eye, supplied with a very strongly developed focusing apparatus for near objects, will, I am firmly convinced, survive the competition.

"At all events, the law of evolution is as interminable as the law of gravitation. I may be mistaken in my prophecy of the exact changes which are yet to occur in the human eye, but on one point, surely, it is impossible to be mistaken. That point is that there will be change. The entire spiritual, intellectual and physical universes in which man lives will change. And man himself, his eyes included, will inevitably change with them."



INSIDE OF HORSE'S EYE

Back of inside of horse's eye. It is the upper part which sees the road at night

Safety at Sea

American Ship "Malolo" Survives Terrific Collision

AFTER the tragic loss of the *Titanic* in 1912, due to collision with an iceberg, the leading naval architects of the world met in London, and the International Conference, as thus assembled, laid down certain rules for ship construction, designed to safeguard life at sea.

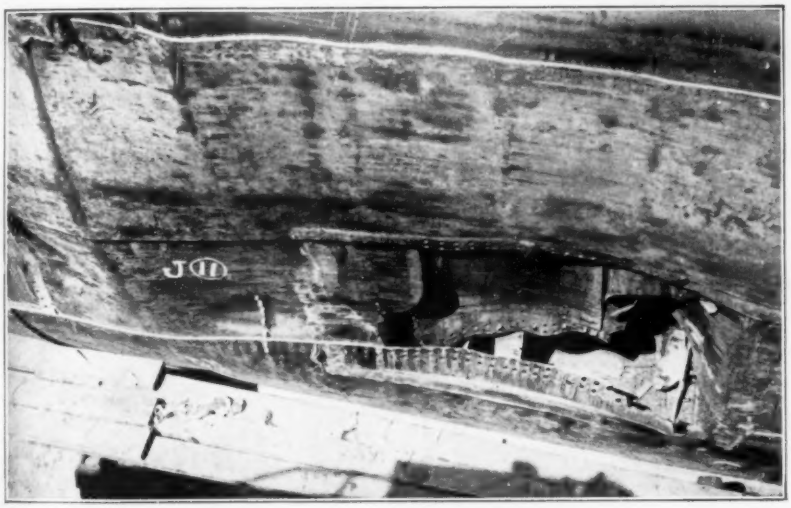
The recently completed passenger ship *Malolo*, 582 feet long, 83 feet beam, 22,000 tons displacement on a full load draft of 28½ feet, and 22 knots speed, was designed by Wm. F. Gibbs of New York in full compliance with the International Conference requirements. Furthermore, he exceeded the Conference stipulations by installing a central control system for the simultaneous closing of all scupper valves, thus preventing flooding through these valves—a frequent contributory cause of foundering. Mr. Gibbs also gave special attention to stability as a safeguard against capsizing.

At the very outset of her career, on her trial trip in fact, the *Malolo* was rammed squarely amidships by a heavily loaded Norwegian ship, the *Jacob Christensen*, which struck her squarely on the bulkhead between two boiler rooms, both of which were opened to the sea and flooded. The stem of the *Christensen* protruded below water and ripped open the plating, from just above the boiler floor to a height of 15 feet. It was a terrific blow; but the instant closing of the watertight bulkhead doors and the scupper valves, coupled with the heavily stiffened bulkheads, saved the ship. With some 5000 tons of water in her two boiler rooms, she settled to 36 feet draft forward and 26 feet aft, but showed only a slight list to port.

The International Conference called for closer spacing of bulkheads, resulting in smaller compartments. Note the improvement of the *Malolo* over the *Titanic*. The latter, 886 feet long, had only 15 compartments; the *Malolo*, 582 feet long, has 14 compartments.

CRUMPLED BOW OF "CHRISTENSEN"

Remarkable toughness of folded-up ship plating is shown by this photograph



Photographs by P. and A.

WHERE "MALOLO'S" PLATING WAS CRUSHED IN

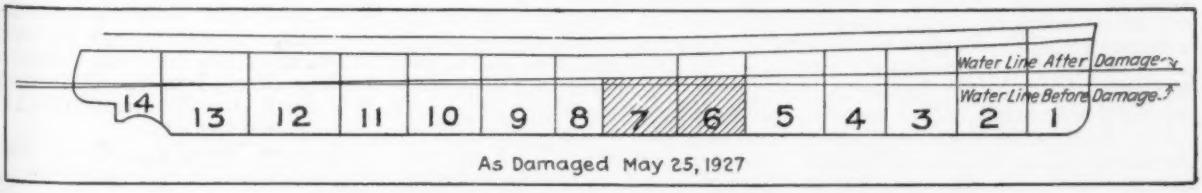
Bow of Christensen *struck* Malolo *squarely amidships and ground along her port side for a distance of 25 feet, bursting in her plating and admitting some 5000 tons of water*

The *Titanic*, if her engine-room compartment had been pierced, would have taken in 5000 to 6000 tons of water. The *Malolo*, with her two midships compartments flooded, took in only 5000 tons.

Mr. Gibbs, writing in *Marine Engineering*, says "While the provisions of the International Conference for Safety of Life at Sea, held in London in 1914, have not yet been adopted by this country, the *Malolo* complies strictly with these rules." Why this astonishing neglect? Are we altogether indifferent to the safety of American voyagers?

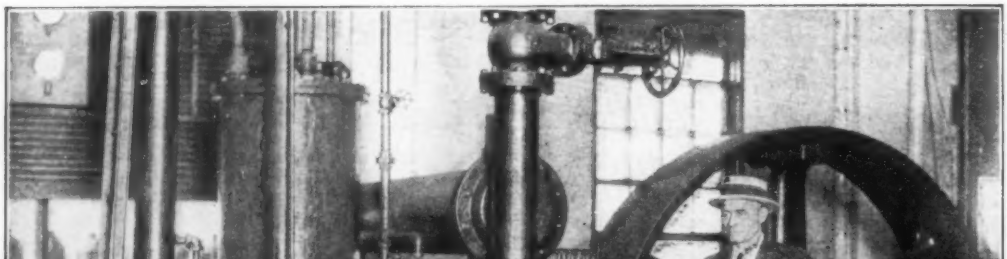
ANOTHER most important safety provision, which the writer strongly urged at the time of the *Titanic* disaster, was the raising of the bulkhead deck, and hence the bulkheads, to a higher level. In the *Titanic* the bulkheads extended only 10 feet above the load line; but in the *Malolo* they rise 16½ feet above water amidships, and at the bow 21½ feet. Moreover, by reference to the accompanying diagram, it will be seen that the collision bulkhead extends one deck above the bulkhead deck.

The owners, the Matson Navigation Company, and Mr. Gibbs, the designer, are to be congratulated on the performance of this fine ship.



SKETCH SHOWING EXCELLENT BULKHEAD SUBDIVISION

Prior to loss of Titanic, *bulkheads were spaced too widely; they did not extend sufficiently high above the water; and compartments were too large. The* Titanic's *bulkhead deck was only 10 feet above water amidships; but the bulkhead deck of* Malolo *is a full 16½ feet above water*



All photographs courtesy of the General Electric Company

ONE OF THE HUGE AIR-COMPRESSING MACHINES

In order that argon gas may be extracted from the atmosphere, the air must first be compressed to a pressure of 4000 pounds per square inch. Above is shown one of the machines that accomplishes this stupendous work

Nobility at Work

How Some of the "Noble" Gases Are Finding Valuable Applications in Industry

THE air is composed of about four-fifths nitrogen, one-fifth oxygen, a small amount of carbon dioxide and traces of other gases, such as helium, argon, neon, krypton and xenon. It is less than 35 years ago that any one of these latter was obtained for the first time. They are not elements which can be mixed with other elements or compounds in test tubes or retorts to produce new compounds, for these gases are "noble" ones, and in more ways than one.

Xenon, for example, is present in the air in the proportion of only one in 170,000,000 parts; argon, the most common of the five, forms only about 94/100ths of 1 percent of the air. Such rarity makes these gases noble; not only are they uncommon, but they refuse to join with any other elements, or even with the others in their own exclusive circle, in the formation of chemical compounds. They are even more noble than are the "noble" metals—gold, platinum, iridium, et cetera—which are not tarnished by exposure to the atmosphere but which can be made by the chemist to combine with other elements in the formation of new compounds. The noble gases are sufficient unto themselves; and it is not surprising, therefore, to note that little space is devoted to them in the average textbooks on chemistry.

Of the five rare gases — argon, helium, neon, krypton and xenon— three are now at work. The other two, krypton and xenon, could be made to labor, but they are so rare that to harness them commercially would hardly be feasible. All of them are being given off constantly by the earth in springs, in natural gases, by volcanoes, and even from rock formations.

HELIUM was the first of the five gases to be discovered. It was found by Lockyer in 1868 in India, but, seemingly paradoxical, it was not in India. Its exact location at the time was about 93,000,000 miles away, and the time was that of a solar eclipse. By means of the spectroscope, scientists discovered in the corona of the sun a gas which had not been found on the earth. To the new element was given the name helium, from the Greek word *helios*, or sun.

It was not until 1895 that Ramsay discovered the gas in the earth's atmosphere. During the World War, helium attained prominence because of its value for inflating dirigibles. Being inert, it is non-inflammable and non-explosive, and, being buoyant, it is ideal for use in balloons, except for its cost. Before the war, helium could be distilled from the air at a cost of about 1700 dollars per cubic foot; today the production cost is but a small fraction of that amount. Even so, however, the expense of filling a dirigible with it is more than a quarter of a million dollars.

As for neon, which constitutes one in 55,000 parts of the air, it has been found that a beautiful red glow is produced by passing an electric discharge through a glass tube containing a slight amount of the gas. Hence neon is now commercially at work in a novel type of electric sign in which letters or designs are made from glass tubing. Neon, from the Greek word *neos*, or new, was discovered in 1898 by Ramsay and Travers.

Krypton, from the Greek word *kryptos*, or hidden, and xenon, from the Greek word *xenos*, or strange, were also found in the same year, 1898, by the same two men.

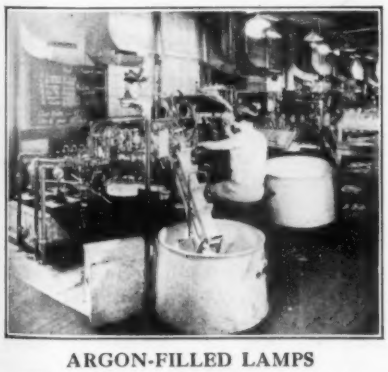
Argon was first obtained by Rayleigh and Ramsay in 1894-1895. The name is derived from the Greek word *argos*, or inactive. It is the commonest of the five noble gases and is by far the most valuable commercially, saving us annually three hundred million dollars in electric light bills.

OF the tungsten-filament lamps, the larger sizes are gas-filled and the smaller ones are vacuum lamps. The 1926 production included 173,000,000 vacuum lamps and 121,000,000 gas-filled ones. The vacuum lamps averaged 33¼ watts each, and the gas-filled ones 96 watts. The amount of light produced by each type was not in proportion, however. The average gas-filled lamp consumed nearly three times as much current but produced 4½ times as much light. Thus the gas-filled lamp of 1926 was about 55 percent more efficient than the average vacuum lamp.

Two gases are used, nitrogen and argon. Nitrogen is inert in that it does not combine readily with other substances, but it can be made to participate in many reactions. Different mixtures of nitrogen and argon are used for different sizes and types of lamps, with practically all argon in the case of the average size lamp, and about half nitrogen in the large, high-voltage lamps.

The point might be raised as to why the gas-filled lamp has not superseded all vacuum lamps since it is so much more efficient. The answer is that special operating conditions exist with gas-filled lamps, in that a special design of filament is needed, et cetera, so that gas-filled lamps consuming less than about 0.4 ampere are as yet less efficient than vacuum lamps.

Although as stated, Ramsay discovered argon in 1894, for 20 years no practical application was made of it. In 1913, however, Dr. Irving Langmuir, in the Research Laboratory of the General Electric Company, put a little argon in a lamp bulb containing a specially designed tungsten filament. The presence of the gas made it possible to increase greatly the amount of current passed through the filament and to increase its temperature. The higher the temperature, the whiter and brighter the light produced, and the greater the efficiency.



ARGON-FILLED LAMPS

The machine illustrated removes the air from glass lamp bulbs, puts argon gas in the evacuated space and seals the bulbs

Early experimenters had tried gas-filled lamps, but the vacuum carbon lamp was found to be better. Dr. Langmuir's experiments showed, however, that a tungsten filament heated in a gas-filled bulb entirely freed from water vapor lasts longer than when heated in a vacuum; and that the heavier the gas, the slower the evaporation of the tungsten. For example, it was found that argon reduced the filament evaporation to 1 percent of that which occurred in a vacuum at the same temperature.

THE addition of the gas to increase the life of the filament means an additional heat loss, but, by using either a large filament or a coil of small filament, the heat loss has been overcome by the higher temperature and the improved quantity and quality of the light.

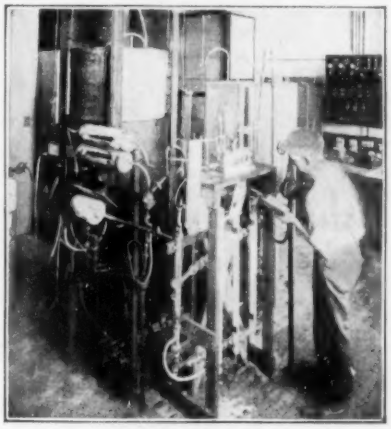
The argon used by Dr. Langmuir in his experiments back in 1913 was imported from Europe and cost 10 dollars per cubic foot. Many thousands of cubic feet of the gas are now used every week in lamp manufacture, and, needless to say, the cost of argon today is far below the figure for 1913.

Just at the time the World War was beginning, an American, J. G. Wild, succeeded in escaping from Europe with a sufficient quantity of the then hard to obtain argon gas with which to conduct exhaustive experiments in producing and purifying the gas. By the fall of 1914 the characteristics of the gas had been learned to such an extent that it was possible to supply the lamp development laboratory of the National Lamp Works at Nela Park, Cleveland, with some argon for use in lamps. In February of the following year regular shipments of the gas were started to different lamp factories. Crude argon—with varying amounts of other gases as impurities—was purchased from an air-products company in this country and purified in the laboratory before shipment to the lamp factories.

Each year found the consumption of argon much larger than that of the preceding year, and in 1919 a complete argon production and purification plant was built at Cleveland. Here clean air is sent through a pipe to a compressing machine where a pressure of 4000 pounds per square inch is applied.

More than simply pressure is required, however, if the air is to be reduced to a liquid; its temperature must be reduced to 220 degrees below zero, Fahrenheit. The compressed air is therefore directed into interchangers, tanks in which the temperature is decreased almost to the point where the air becomes liquefied.

From the interchanger, the highly-compressed and low-temperature gas passes through an expansion valve into the fractionating column or still.



PURIFYING ARGON

This is the equipment used for purifying the crude argon delivered from the compressor

This still is heavily insulated to keep out heat, for the temperature within the still must be 300 degrees below zero. When the air goes through the expansion valve the pressure suddenly drops from 4000 to six pounds per square inch. So suddenly is the pressure lessened that the temperature decrease is sufficient to cause the air to become a liquid.

THE air in the still has been liquefied by compression, chilling and expansion, but it immediately starts to turn back into gases. The nitrogen is the lightest or most volatile of the mixed gases, so it is the first to return to the gaseous state. The oxygen, which is heavier, trickles down the sides of the still as a liquid. The argon starts to go with the oxygen.

Part way down the sides of the still, however, the argon begins to become a gas, following the example of the nitrogen. But the apparatus is so constructed that the argon, becoming a gas, is unable to join the gaseous nitrogen with which it parted company at the top of the still. Instead, it is trapped and led to tanks labelled "Crude Argon."

The impure, or crude, argon piped from the still is subjected to a heat treatment which removes the impurities. Then it is compressed again and loaded into cylinders, ready to be shipped to lamp factories in all parts of the world. Each cylinder holds 300 cubic feet of the noble gas, which weighs slightly less than 30 pounds. Open the valve of one of the cylinders and a hissing sound can be heard as the argon escapes; but as for seeing, tasting or smelling the gas, it can't be done.

CATHEDRAL OF ST. JOHN THE DIVINE

Final design of the world's third largest cathedral, showing the square tower which has been substituted for the original spire. Length of church 601 feet, interior height of nave, floor to vault, is 125 feet, height of central tower 400 feet

Building for the Ages

Built of Large-Size Stone, Bedded in Cement Mortar, St. John's Cathedral Should Be As Lasting As the Pyramids

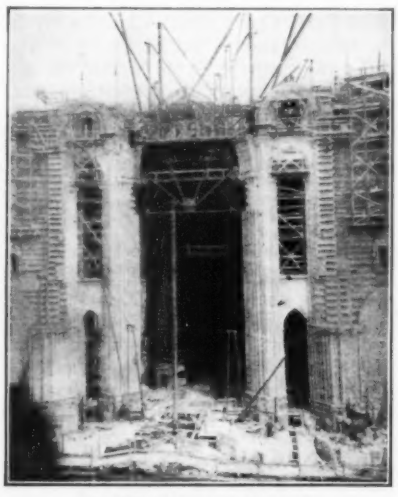
By J. BERNARD WALKER

UPON its completion, St. John's Cathedral will take rank as the third largest place of worship in the world. The basis of this comparison is the total ground surface covered by the building. St. Peter's, Rome, stands first with an area of 227,069 square feet; Seville Cathedral, Spain, second with 128,570 square feet. These are followed by St. John's, New York, which will cover 109,082 square feet. In exterior length, it will stand second, measuring 601 feet as compared with St. Peter's, which measures 710 feet.

Architecturally considered, the crowning glory of St. John's will be found in its truly noble nave, in which, by the insertion of two lines of majestic piers 85 and 98 feet in height to assist in carrying the vault, the architect has been able to secure a clear nave width of 96 feet between the clerestory walls. This is several feet wider than the nave of St. Peter's, which is given as 85 feet by Fletcher in his recent notable work, "A History of Architecture."

When Mr. Ralph Adams Cram was confronted with the task of remodeling the Romanesque design of the first architects, Messrs. Heins and La Farge, he decided to adopt the style known as Thirteenth Century French, as developed by the medieval cathedral builders in those superb examples, Notre Dame and Chartres, Amiens and Rheims. The style is marked by great simplicity and dignity and a sparing use of the elaborate sculptural and other decorative effects which were to characterize the later decorated, flamboyant and perpendicular cathedrals of France and England.

So felicitously has Mr. Cram adapted the Thirteenth Century style to the ritual and congregational requirements of a Protestant Cathedral of the first rank, that the writer, at least, does not hesitate to say that St. John's, both within and without, will surpass its great prototypes in that particular quality of combined simplicity and dignity to which we have referred. When the student who has familiarized himself with medieval cathedrals, first enters the nave of St. John's, looks through the two lines of soaring columns that sweep, unbroken, from floor to roof, and appreciates the vast stretch of 96 feet from clerestory window to clerestory window, he will realize that here is something which, for sheer majesty of effect, is unmatched among all the cathedrals of the world.



WEST END OF NAVE

View shows piers completed and main arch weighing 250 tons under construction

But the purpose of the present article is to deal with the permanence, the enduring quality of the construction of America's greatest Cathedral. How long will it endure? For how many generations, throughout how many centuries, will it stand the buffeting of wind and weather, the alternating attack of torrid heat, driving rain, and disintegrating frost? The writer was asked that question by a visitor from the west, who had traveled far to look upon the structure, of whose vast proportions he had heard so much. We answered, "If you could

return to earth five thousand years from now, you would find St. John's standing, to all outward appearances, as you see it today." In explanation of our confidence, we quoted a well-known sculptor, who was then engaged in carving a monumental work upon the vertical face of a mountain of solid granite. Wishing to know the probable rate of disintegration of the granite, he consulted the state geologist, who, after a careful study of the problem, which included laboratory tests, set down the rate of wear of the surface at one inch in several thousand years.

Now, the exterior of St. John's is clothed with selected granite of a quality equal to that above referred to. If the action of the weather removed one inch in five thousand years from the granite face, the loss would not be visible to the eye, even on the bold and massive carvings and mouldings that adorn the structure.

Similarly, the interior surface of the cathedral, which is of selected Indiana limestone, a material which hardens under atmospheric effects, will suffer no disintegrating effects that will be noticeable as the centuries pass by.

There remains as a cause of failure the question of faulty design, poor materials, and careless workmanship; and it is here that St. John's greatly surpasses in its structural strength and workmanship the cathedrals of the Middle Ages.

In those early days, money was scarce and the world had lost many of the secrets of construction, notably that of the making of the cement, which had rendered so lasting the work of those master builders, the Romans. It was an age of small-stone-and-mortar construction. Lack of suitable tools and appliances at the quarries, poor roads and inadequate means of transportation, and the lack of capital, drove the early builders to the use of building stone of small size; and in binding together this material in their piers and walls, they were restricted to the use of lime mortar—some of it good, but much of it, as many a catastrophe proved, of wretched quality.

INTERSECTION OF THREE GROINS

View from platform above nave vault showing the three massive intersecting groins, or arches, seen in the lower left-hand view of the nave. The keystone weighs five tons

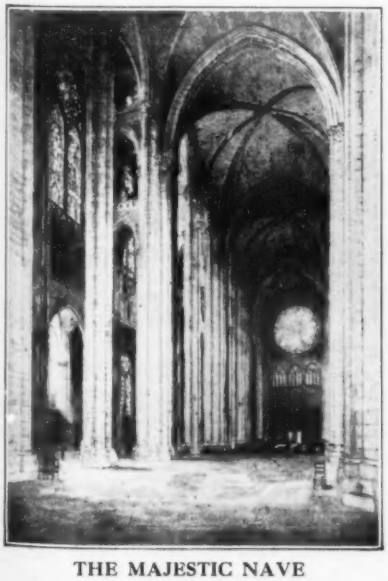
Professor Goodyear believed that the outward inclination of the clerestory walls of the great French cathedrals was intentional, and was done to counteract the foreshortening effect, as the eye of the spectator ranged upward. The writer believes that this effect was due entirely to the settlement, or closing up, of the masonry under the thrust and counterthrust of vault and flying buttress. A similar displacement, in the opposite direction, occurred when the unbalanced thrust of the aisle arches pushed the lower half of the piers inwardly towards the nave, thus accentuating the outward inclination of the clerestory walls.

Now, all of these effects may be traced either to faulty design, due in some cases to a lack of technical knowledge of the amount of thrusts and loads that would be developed, or to what looks suspiciously like a happy-go-lucky, cut-and-try method of building. Not to all of the cathedral structures do these remarks apply. There are some, like Salisbury (if we except the tower and spire, which were never contemplated by the original architect) which stand today as secure and perfect as when they were consecrated five to seven centuries ago.

St. John's has been designed and is being built with a careful avoidance of the pitfalls which so often brought disaster to the medieval churches. The load upon every pier, the thrust against every buttress, has been calculated with close exactness. The crushing strength and the safe limit of loading of each kind of stone are known, and all the parts are so proportioned that in every element of the vast structure

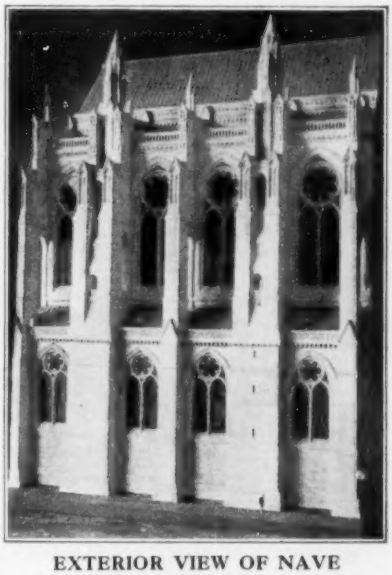
IT was no uncommon occurrence for the tower over the central crossing to come crashing down, not many years after the completion of the church. Sometimes the disintegration of the masonry would be gradual, as in the case of the tower and spire of ancient Chichester Cathedral, which fell as late as the middle of the Nineteenth Century. It is to the early fall of the tower of Ely Cathedral that we owe the beautiful octagon built in its place to cover the crossing. The curious double arches at Wells were hastily thrown up to buttress the four piers that were yielding under the weight of the tower. The lovely tower and spire at Salisbury, the top of which leans some two feet out of the perpendicular, owe their present security to emergency measures in the shape of 112 flying buttresses and inclined stone struts, without and within the walls of the cathedral, to say nothing of a score of iron bands inserted to hold the sliding masses of masonry together.

Nor were the great French cathedrals exempt from trouble. The 500-foot spire of Beauvais Cathedral crashed down upon the crossing; and, twice, the vault, 157½ feet in interior height, thrust out the walls of the choir and fell upon the choir stalls and altars below. In rebuilding Beauvais, the number of piers in the main arcades was doubled, and additional buttresses were run up between the walls and the original buttresses.



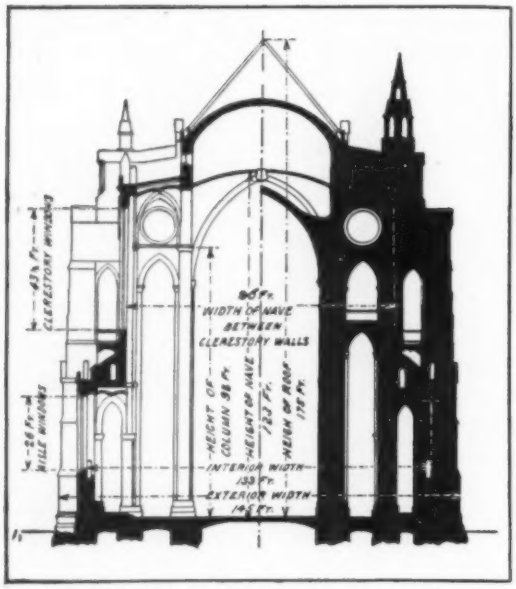
THE MAJESTIC NAVE

Note the noble line of piers, 86 and 98 feet high, which assist in carrying the vault The nave is 96 feet in width



EXTERIOR VIEW OF NAVE

The massive buttresses are necessary to resist the outward thrust of the stone vault. The exterior is of massive simplicity



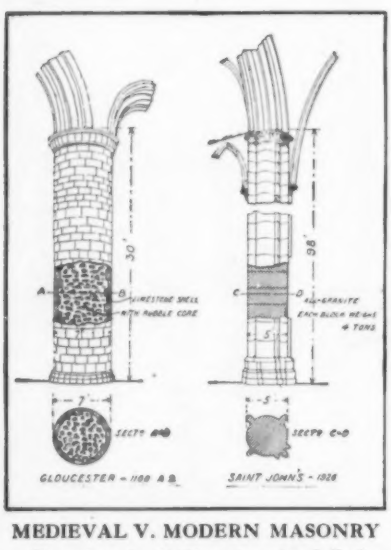
SECTIONS THROUGH THE NAVE

There are no flying buttresses as in medieval cathedrals. The space they would cover is here included in the nave, rendering this the most spacious nave in the world

there will be a wide margin of safety.

It is safe to say that the piers of St. John's will forever remain as plumb as they are today. Turn your attention to the drawing showing a cross-section through one of the vast abutments, and you will feel satisfied that the thrust of the nave vault, great though it will be, will never push these huge masses of granite from their appointed positions.

As regards the materials of construction, St. John's may be called a big-stone job. To make clear what we mean by this, we have made a comparative drawing of a pier of Gloucester Cathedral (1100 A.D.) and one



MEDIEVAL V. MODERN MASONRY

Gloucester pier (1100 A.D.), outer shell of cut stone with core of rubble and lime mortar. St. John's, 4-ton granite drums, with cement mortar

of the intermediate piers of St. John's. The builders of the Twelfth Century, Norman Church, and of all later medieval churches, could not afford to construct their piers of cut stone throughout; so they built an exterior shell of fine squared stone, from six to twelve inches thick, and filled in the center with a core of rough, broken stone, set in lime mortar.

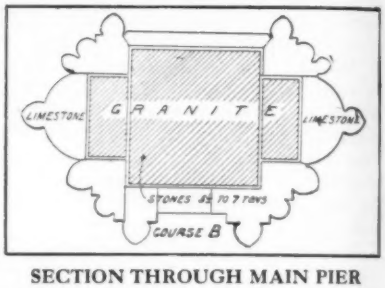
When the load of the upper walls came upon such piers, the rubble core settled more readily than the carefully jointed ashlar casing, and the shell carried the greater part of the load. With the passage of the centuries, the mortar frequently disintegrated, the center rubble core lost its bearing quality, and practically the whole load rested on the thin outer shell, which would bend or bulge, flakes of stone splitting off, and the work threatening an early fall.

THIS is the trouble with the piers that carry the dome of St. Paul's, which, upon investigation, were found to consist of a thin shell of Purbeck limestone, backed by a mass of badly disintegrated rubble and lime mortar. They are being strengthened by injecting liquid cement under high pressure.

In several instances the threatened collapse of the towers of medieval cathedrals was met by heroic efforts to hold up and repair the heavy masses of crumbling masonry. "Murray's Handbook" records in dramatic description, work of this character. Take the case, for instance, of the enormously heavy tower of St. Alban's, with walls six or seven feet in thickness, which was saved from imminent collapse in 1871.

The tower, thousands of tons in weight, was crushing the massive piers upon which it stood. The mortar used in building the piers had become pulverized. The tower leaned gradually to the northeast pier, which burst open, causing rents from the crown of the northern and eastern arches which extended upwards to the parapet at the top of the tower. "Adjacent arches were hastily bricked up and double shores and trusses were inserted. A cluster of heavy timbers, abutting diagonally against the northeast corner of the tower, bent like bows under the pressure and the northeast tower crumbled until there was a continuous shower of dust and small particles dropping around it. After many days and nights of continuous labor, the downward progress of the tower was arrested. The great trusses in the northern and eastern arches had caught the shifting mass and were upholding it." The tower was then rendered secure by inserting cement concrete in the foundations and by repairing the tower and piers with brickwork and liquid cement grout.

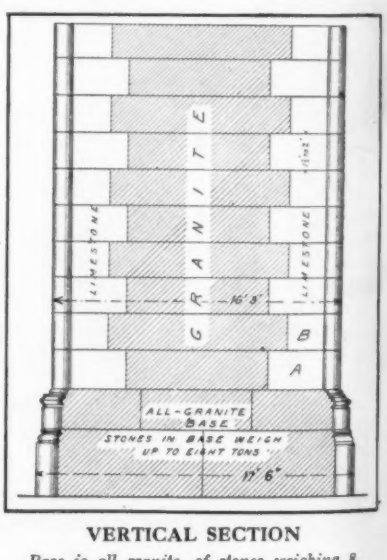
Not always, however, did these emergency measures save the medieval tower from disaster. Take the case of the charming old cathedral of Chichester dating from the 12th and 13th centuries, the piers of whose central tower, after centuries of service, began to give way.



SECTION THROUGH MAIN PIER

Note the core of cut granite blocks weighing from five and one-half to seven tons

Quoting Murray: "In the northwest tower, fissures were discovered wide enough to admit a man's arm. Iron clamps and traps had been applied from time to time to stay progress of the settlement. New stone work was built up, parts of the piers were recased and bonding stones were inserted—but as this work went on, the amount of bad construction, disintegration and decay in the old masonry, developed itself in a manner exceeding all experience, and presented most serious and unexpected conditions. Old fissures ex-



VERTICAL SECTION

Base is all granite, of stones weighing 8 tons. The successive courses of squared granite and limestone are bound together with steel clamps

tended themselves into fresh masonry and new ones made their appearamce. Shoring was resorted to, but the walls began to bulge. Cracks and fissures, some opening and others closing, indicated that fearful movements were taking place throughout the parts of the walls connected with the western piers; and it was determined that the bulging should be checked by applying a jacket of solid timber.

"The work continued, with new fissures appearing and failures increasing, until the following Wednesday, when crushed mortar began to appear from the old fissures. Flakes of facing stone fell and the braces began to bend. Work continued far into the night, but before noon it was seen that the fall of the tower was inevitable. Inhabitants living near the building were warned and not long after noon, the spire inclined slightly to the southwest, then descended perpendicularly into the church, as one telescope tube slides into another . . . the mass of the tower crumbling beneath it.

"THE ruin presented a compact mass of detached materials puddled together in the form of a rounded hill which rose at the summit nearly to the level of the triforium capitals, and sloped gradually downwards into the four arms of the cross."

Consider the piers of St. John's. The main piers, measuring 11 feet by 16 feet, three inches, consist of a heavy outer casing of Indiana limestone, with an inner core of massive, squared granite blocks, each weighing from 5½ to 7 tons. The limestone casing consists of selected stones, most of which are several tons in weight. Not only is the work set in a concrete mortar that hardens to the consistency of the stone itself, but, at each course, it is tied together by galvanized iron clamps, one half inch thick and two inches in width, as shown in one of the accompanying drawings.

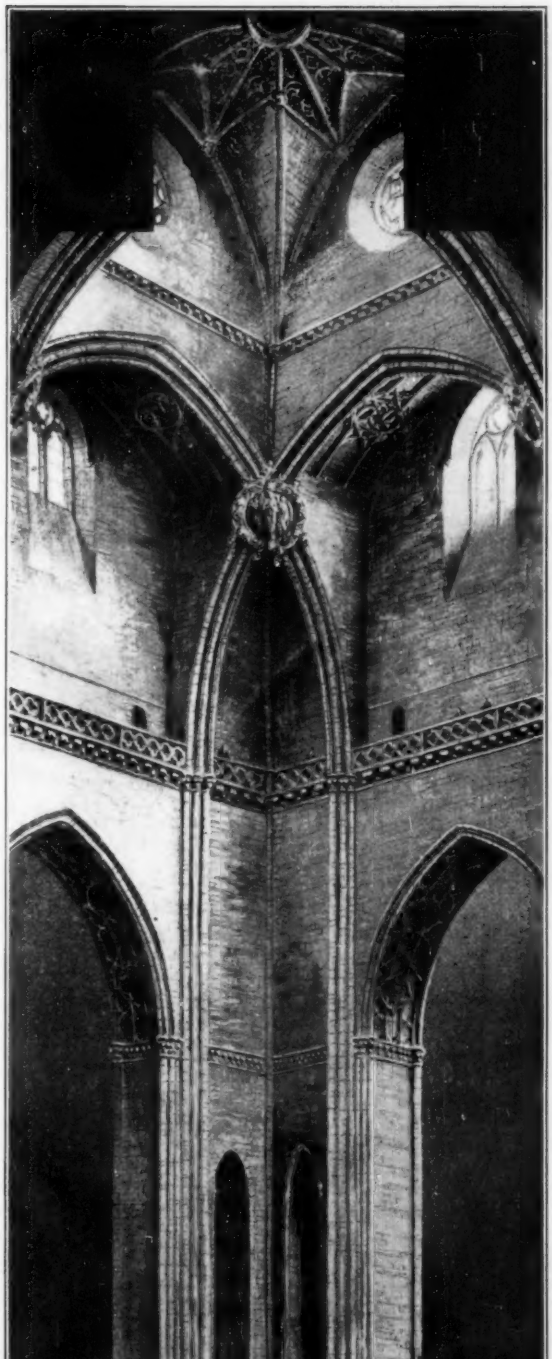
Consider also the more slender piers, intermediate with the main piers. These have the amazingly slender proportions of a least diameter of five feet to a length of 98 feet, or about one to 20. To guard against any buckling under the load they carry, it was decided to make each course of a single granite block, of a maximum diameter of seven feet, measured across the mouldings. These blocks weigh up to four tons apiece, and, set as they are with thin cement-mortar joints of great tenacity, they give these tall piers approximately the strength of a single monolithic shaft.

The same combination of durable, selected stone, cement mortar, abundant iron clamping and careful workmanship, prevails throughout the whole fabric of the cathedral—it is built for the ages.

And a word about the workmanship. The contract was awarded to the firm of Jacob and Youngs, Inc., who have thrown themselves with manifest enthusiasm into the prosecution of this great work. By the use of the most up-to-date erecting plant, they have carried up the majestic nave of this cathderal at a rate which has never, we believe, been approached in any previous work of this kind. In great part, this has been due to the unique design of the steel scaffolding, which extends the full length of the nave and which serves to carry the steel centering upon which the great arches of the nave have been built.

MATCHING the zeal of the contractors, is the keen interest which is everywhere manifest among the men. As an engineer, the writer can state that never has he seen a finer job of masonry, or one in which the cutting of the stone and its setting showed greater evidence of exactitude and care. There is a suggestion, indeed, of the loving care with which the medieval builders, as at Chartres, bent to their task. The medieval cathedral was at once the most majestic and most beloved building in the cities which it so grandly dominated. Noble and peasant would labor, sometimes side by side, in its erection.

"The men seem to be deeply interested in this work," I remarked to one of the master workmen. "We are," he said. "At heart I know that I am. This is the third cathedral I have helped to build; and I feel it is an honor to labor upon a great work like this that is being raised to the glory of God."



WITHIN THE GREAT CROSSING

This will afford one of the most impressive views in St. John's. The lower section is 100 feet square. If the tower above had been carried up on this dimension, it would have presented too great a bulk and dwarfed the cathedral, despite its great size, throwing the design out of balance. The problem was solved by building four massive, intersecting arches, 60 feet apart, over the crossing. Upon these will stand a tower 60 feet square. Interior height, floor to vault, 240 feet

Successful Inventors—XI

How a Piece of String, Plus a Paper Bag and an Idea, Equalled a Nation-Wide Business

By MILTON WRIGHT

"THE opportunities for profitable invention today are practically without limits. The American people are always wanting things and they have the money to pay for what they want. What more favorable situation could an inventor ask for?"

So says Walter Henry Deubener, who developed, from a simple little invention, a business which extends from coast to coast. All of Deubener's success is bound up with a paper bag and a piece of string.

INVENTORS NEED INSPIRATION

Mr. Deubener's source of inspiration is pictured with him. "The business wouldn't be what it is without her," he says

Deubener was a grocer. With his wife he ran a cash and carry store on the balcony of a ten-cent store in St. Paul, Minnesota. Being ambitious for bigger and better business, they tried to please their customers in every way possible and to induce them to buy as much as they could. How to get women to pay for and carry away more groceries with them—that was the problem the Deubeners used to lie awake nights trying to solve.

"MANY times a day I would notice that a customer's purchases were limited by her arms rather than by her pocketbook," said Deubener in explaining how he arrived at his invention. "I realized that if I could make packages easy to carry, my customers would buy more and would keep coming back. With this in mind we built a special wrapping counter where several articles were wrapped together in strong paper, tied with heavy string and a wooden handle attached. This helped somewhat, but we found that it cost too much, not only for the supplies but for the clerk's time as well. Then, too, the finished package usually was untidy and too awkward for the customer to handle easily.

"Next we tried selling market baskets. They showed a saving in clerk's time, but there were a lot of objections. They took up too much space in the store and the customers didn't like to carry them, because the baskets scuffed their clothing. For month after month we wrestled with that problem. We couldn't forget it if we tried, for not a day passed without several customers saying, 'Yes, I need this,' or 'I should buy that, but I can't carry any more.'

"I used to lie in bed at nights thinking about it, and one night the solution came to me. Mentally I took a paper bag and punched two holes in each side near the top and two near the bottom. Then I passed a strong double cord through the holes and around under the bottom and extended it upward to form handles at the top.

"As soon as we got to the store the next morning we grabbed up the first empty paper sack we could lay our hands on and passed a looped length of common white wrapping cord around it and through the holes just as I had visioned it the night before while lying in bed. We stuffed it full of canned goods—50 pounds or more—and carried them easily around the place. The paper didn't tear because the weight was supported by the two portions of the string passing under the bottom of the bag. We realized that at last our problem was solved."

"How soon did you place your bag on the market?" we interrupted.

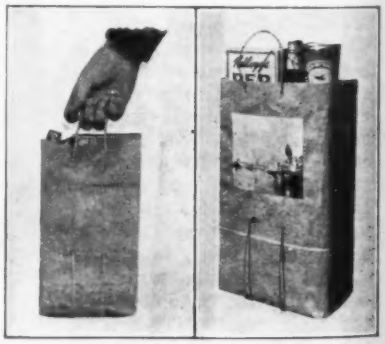
"Only after we had seen a patent attorney," he replied. "We believed we had something in which there were great commercial possibilities and we didn't want anyone else to reap the profits which we thought should be ours. As soon as that first bag was completed we hurried to a patent attorney, explained what we had and asked him to apply for a patent. Only then did we feel safe in taking any steps to commercialize the invention."

"And did you wait until your patent was issued before you placed your bag on the market?"

"No. Why wait? Such paper bags as I had invented were needed right away. Returning from the patent attorney's office, we bought a few ordinary bags and some one-pound balls of string which we cut into nine-foot lengths. (Today we buy our string in carload lots. We punched holes in the bags with an ice pick and ran the string through in the way we had done with the model we had taken to the patent attorney. We made 25 bags in all. Then we cut out colored pictures from the covers of magazines and pasted them on the bags to make them look attractive, for it has always been a theory of ours that an attractive-looking article has many times the selling value of an article of poor appearance.

"WE took the 25 bags to the manager of the 'ten-cent store' where we rented space for our grocery and asked to place them for sale at ten cents each on one of his counters. He consented. Within a half hour they were all gone.

"Feeling now that the value of the invention had been demonstrated we hired two women and set them to work making bags in a small space in a basement. They made 125. These, too, sold as soon as they were placed on sale. Then we went to the head buyer of the 'ten-cent store' chain and he gave us an order for bags to be sold in all of his stores. Next we went to the buyer for the Minneapolis district of the biggest chain



THE SHOPPING BAG DEVELOPS

Deubener's first bag (on the left). Better paper, improved machinery and more attractive decoration enable the latest model to fight dangerous competition successfully

of 'five and ten-cent stores' in the country. He, too, listed them for a trial. They were a success and then they were bought for the 'ten-cent stores' all over the country as well as Canada and Cuba.

"Meanwhile we had moved our workers out of the basement and into a storeroom. We hired a girl and I quit being a grocer and became a factory man. The business was growing fast and I was the busiest man you ever saw. I was sales manager, shipping clerk, machinist, factory superintendent, janitor—everything. They were interesting times. I remember that the door was so narrow I had to carry the bags outside and pack them in large wooden cases out on the sidewalk. At one time I was employing a staff of 125 workers.

"NATURALLY the manufacturing developed into machine production. There were plenty of bag-making machines to be had, but none were adapted to making the new kind of bag I had devised. The big problem became to get a sack-making machine that would turn the bags out in one continuous roll. It took us 14 months before we got what we wanted. We had a special bag-making machine built in Philadelphia to suit our particular requirements.

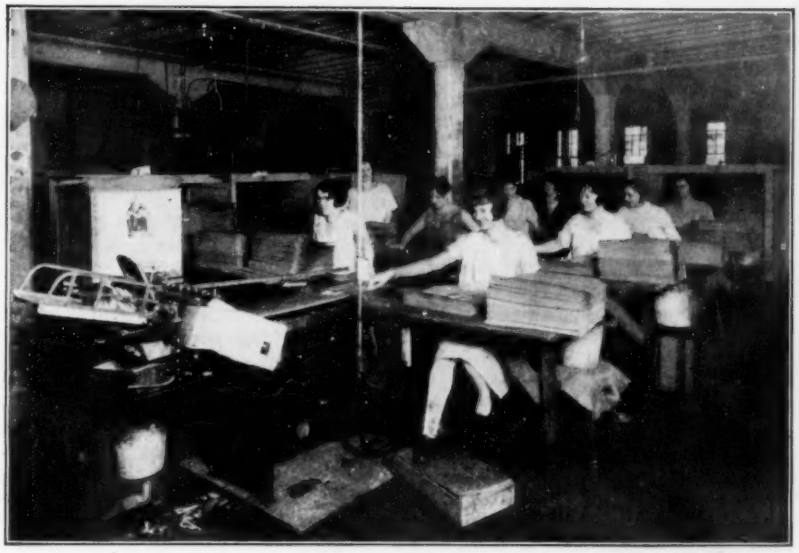
"How many bags have you made and sold altogether?"

"More than fifty million. Our growth has been steady. In 1916 the Deubener shopping bag was nothing but an idea. In 1919 we sold nearly a million of them. We climbed steadily. In 1926 we sold more than one and a half million. This year we will be well over ten million.

"Production methods have kept pace with increased distribution. In the beginning we bought our paper bags in small quantities ready-made. Last year we bought 29 carloads of paper. Whereas we used to buy cord in one-pound balls, now we buy it ready-cut in carload lots. We used to send out the bags to have our name printed on them; now we have our own printing department. Instead of cutting out pictures from magazine covers, as we did to decorate the first few bags, we now buy ten million beautiful lithographs a year."

CHAIN STORES SELL MILLIONS

The first sale to the "five and ten," was 25 bags. Today a picture like the above might be taken in any city in the country



THE FINISHING TOUCH

Bags are bought for two reasons—because they hold things and because they look attractive. These girls are applying the second reason to the bags—beautiful lithographs

"WOULD you say that the shopping habits peculiar to the American public have made your success possible?"

"No, I think that the shopping habits responsible for our bag's success are world-wide. As a matter of fact we have sold our bags to dealers in nearly every civilized country on the globe. Not long ago we licensed a firm who opened a branch factory in England. Naturally, we have taken out patents in the leading countries of the world."

"What about competition?"

"There is plenty of it and it keeps us constantly on our toes. We have managed to develop, however, by constantly giving a better bag and better service. We have worked out labor-saving machinery to reduce costs; we have been always on the alert to improve the appearance of the bag and make it of stronger paper. We now have ceased calling it a paper bag and call it a 'leatherlyke' bag because of the unique appearance we have been able to give it."

"But what you seized was an unusual opportunity for a useful invention, was it not?"

"Not at all. There are more opportunities for profitable invention today than there were in 1917 when I made mine. The inventor, of course, must proceed logically. From my experience, I should say that the first thing to do is to make sure that your idea is practical. Then find out that there really is a public demand for it. Next, select a reliable, experienced patent attorney and apply for a patent. If you have ample finances, sufficient business experience and all the other necessary qualifications, then the way for you to make the most money out of your invention is to do your own manufacturing and selling, for you will be more enthusiastic about your own invention than anyone else would be and you will work harder. If you lack sufficient business ability or finances, then try to make some arrangements with a reliable manufacturer on a royalty basis.

"THERE is nothing wonderful or mysterious about business or making money from the right kind of an invention. Successful business is nothing more than an accumulation of a lot of little policies carried out intelligently, carefully, continuously and energetically. There are many inventions that are impractical, of course, but if you have something the public needs, then plain common sense and hard work will bring your reward. At least, we have found it so."

"Mr. Deubener, throughout our conversation you have been saying, 'we.' Whom do you mean when you use the word 'we'?"

"Why, my partner, Mrs. Deubener and myself. We are partners in business as in everything else. Our business wouldn't be what it is today without her help. I didn't mention it before, because I thought it was self-evident, but a fine, 'A Number One' wife is a valuable asset to every inventor and business man."

Conservation or Extinction?

How Two Creatures, Living at the Earth's Antipodes, Were Blotted Out of Existence by Human Greed

By Dr. LEON AUGUSTUS HAUSMAN

WHAT is it to be "as dead as the dodo?" It is to be dead specifically, as the scientist would say, as well as individually. As a general thing, in animal and plant life, individuals die, but the species, or "kind" remains, represented by other individuals. When, however, the individuals making up a species keep growing fewer and fewer, and finally die out altogether, then that particular form of life is dead specifically—there are no more of its kind left—it is extinct. As long as there are some individuals of a species living, there is the chance that by surrounding these forms with the favorable conditions for their life and living they may be induced to increase again. This is what we mean by conservation, used in its present-day sense. Conservation, from a biological viewpoint, goes farther than merely an attempt to preserve what is valuable; it has no less an object than to promote its growth and expansion. The inevitable corollary of conservation is increase; the inescapable consequence of prodigal use is extinction.

NET FOR PIGEON SNARING

With such nets, and with guns, clubs, long poles, and sulfur pots, thousands of pigeons can be taken and destroyed in a single night

IN all the realm of the history of living things we can find no better illustrations of the obliterative effects of unrestrained human greed upon vigorous living things, than in the melancholy stories of the extinction of two of our most remarkable forms of life; the dodo of Mauritius, and the passenger pigeon of North America. Think of it: two birds, one great in body, the other great in numbers, forever blotted out of human experience! And this within a comparatively few years; by a comparatively few people; for the gratifying of a comparatively dishonorable desire to glut the appetite!

The opening scene in the tragedy of the dodo begins about the year 1510, and is laid in the Indian Ocean, near the shores of Africa. Here there lies a small group of islands, of which Mauritius and Bourbon are the most important. It was on the former of these that there landed, in the year we mention, a party of Portugese navigators under one Captain Cornelius Van Neck.

Finding themselves in need of provisions and water for the ship, a small party had gone ashore, and soon returned in considerable excitement, bearing tales of a remarkable bird which they had found in large numbers—a bird quite unlike anything which they had ever seen or heard of in Europe. It was the famous dodo, and these were the first Europeans who had ever seen this curious bird. In a published account of his voyages, Van Neck gives some account of the dodo. It seems that the sailors had killed a number of these great birds with clubs, and had tasted their flesh. With the exception of the breast-meat they found it tough and very ill-flavored, and hence dubbed the birds *walckvogel*, or, plainly translated, disgusting birds.

The birds were often seen after this, not only by the Portugese, but also by Dutch sailors, and on the island of Bourbon as well as on Mauritius. Between 1610 and 1620 several live specimens were brought into Europe by travelers as curiosities. There were two species of dodos; the Mauritius dodo and the Bourbon dodo. The former, shown in the photograph of a contemporary drawing, was a bird about the size of a very large turkey. Its color was ashy gray, with a bluish cast, lighter on the throat and upper breast. The short, stubby wings were useless for flight, and bore but a few light yellow feathers, as did also the tail.

The most unusual feature about the dodo was its enormous beak, an organ which served it well in tearing vegetation which comprised its food. The Bourbon dodo was a much more handsome bird, with its silvery white plumage and yellow wings. The bill and feet of this species were of a brilliant yellow, and altogether it must have been, despite its grotesque proportions, a strikingly beautiful natural element in the scenery of the island.

In habits the dodo was supremely torpid, hence its Dutch name, a corruption of the Dutch *dodoor*, a sluggard. So languid, both of perception and gait, were these birds, that they could be easily overtaken by sailors and killed with clubs, as the drawing also shows. In this manner many thousands were killed during the 16th and 17th centuries, and salted down by sailors for food on long voyages.

The cry of the dodo was humorously out of proportion to so huge a bird, and was likened to the petulant cry of a gosling. The last records of the dodo show that it survived until the year 1861. Since that time no one has ever seen the unfortunate bird.

THE causes of its extinction are not hard to determine. In the first place the dodo was not a rapid or prolific breeder, laying but a solitary egg at a time, on an unprotected nest of grass on the ground. Before the coming of the Portugese, the species had been able to maintain itself, but with the advent of the sailors, who killed many of the adult birds with clubs, its numbers began rapidly to diminish. What the sailors began in the way of extermination, some pigs which had been liberated on the islands, completed. These, rooting about, discovered that the dodo eggs were excellent food. Soon the pigs and their progeny succeeded in destroying the nests and eggs of the dodos to such a degree that any natural increase of the species was checked, and soon so lowered that gradually the dodo was forced to give up in despair. So it bowed itself off the stage of life and took up its rôle as a mere record in travelers' note-books, or as a stuffed and mounted specimen in a museum case! Fragments of dodos are preserved in several European museums.

Could the dodo have survived, and have become the object of careful protection, there is the probability—considering its unsuspicious and adaptable nature—that it might have been domesticated and transplanted to many

other climes and become of value for its flesh and feathers.

In 1914 there died, in the Zoological Gardens in Cincinnati, Ohio, what is believed to be the last passenger pigeon. It was a female, and the last of a race of birds which had once filled whole forests of our continent with its cooings, and had darkened the sun in flocks of millions upon millions of individuals. And this no longer ago than many a man now living can remember! What has happened to these vast legions of birds? Ask the dodo. It might tell you that after it had found its way into the realm of extinction via the human stomach, the passenger pigeon came following after, over the same road!

Our American ornithologist, Wilson, writing about 1808, recorded that a single flock of passenger pigeons which he had observed in Kentucky must have numbered over two billion individuals! This was the careful estimate of an ornithologist, not the exuberant statement of an untrained and excited onlooker. Enormous flocks of these beautiful birds, winging their way to their feeding grounds, sometimes stretched out over the sky in dense columns from eight to ten miles in length. Careful observers reported columns of these birds flying at great heights, and taking hours to pass by a given point. Some flocks were over a mile in width, and were estimated to be at least (with very few breaks) over a hundred and fifty miles long.

The passenger pigeon (of which there are many mounted specimens to be seen in our museums and institutions of learning) was one of our most beautiful American birds. Its total length was some 16 or 18 inches, including its tail, which was composed of 12 tapering feathers. In general its upperparts were a bluish slate color, with the loveliest metallic reflections of purple, green, and metallic orange and yellow. The underparts were a rich vinaceous tint, fading to whitish on the abdomen. The tail was broadly tipped with white. The female was duller with more olive-brown and gray. The bird which today most closely resembles it is the mourning dove, and is often mistaken for its now extinct relative. The passenger pigeon formerly ranged from Hudson Bay to the Gulf of Mexico, and from the Rockies to the Atlantic. It seldom found its way to the Pacific Coast, though stragglers were often seen there. It was most abundant east of the great plains.

Its breeding places were forests, in which it constructed in the branches of trees its frail platforms of twigs upon which the two eggs were laid. Several broods were reared during the spring. In the Mississippi Valley, flocks of these birds during the nesting season covered tracts of forest over 200 miles square, and often more than 100 nests could be counted in a single tree!

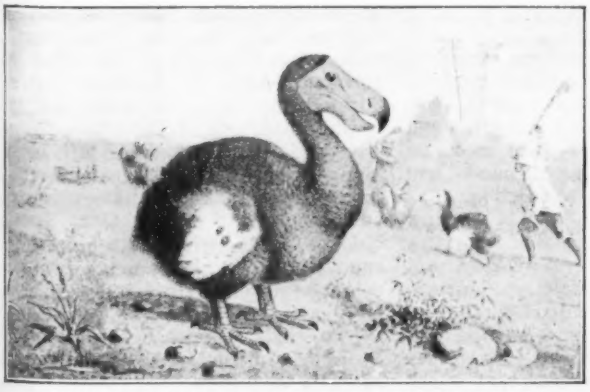
WITH the gathering of the birds to nest at the beginning of the nesting season, there came together for the purpose of slaughter multitudes of men and boys from the neighboring country-sides. As the birds alighted in vast flocks upon the branches of the trees the carnage was begun. With clubs, long poles, guns, nets, pots of burning sulfur, traps, and other implements of destruction the people fell upon their feathered breathren with fearful havoc.

Tons of the bodies of their victims were gathered together. Some were used for human food. Loads of them went to feed pigs. Others were used for fertilizer. Countless thousands were left to decay where they fell. Thousands of men and boys, known as "pigeoners" followed the flocks of birds about, and sent the birds away to many distant points by the ton. In the night the roosting birds were blinded by lanterns and then while bewildered by the light were knocked from their perches with long poles and stuffed into bags. Pigeon meat was cheap, and it was salted down for winter use. Live pigeons sold in city markets for four cents apiece!

It is interesting, and very significant, to note that while the white men were indulging in this reckless slaughter, the Indian tribes, which gathered together at the nesting season for the purposes of social hunting and the augmenting of their winter food supply were exercising a caution and a foresightedness which might be said to be the first conservation program to make its appearance upon our continent. For the Indians took merely the young in the nest, and even then did not deplete whole areas as did the whites.

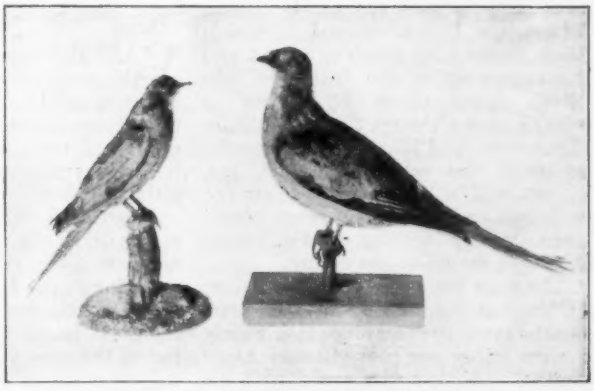
Attempts to legislate against the wholesale and unregulated butchery of the wild pigeons were laughed down. No one thought it possible that a bird represented by such enormous numbers, and rearing two, three, and even four broods a year, should need protection by law! However the numbers of the pigeons grew steadily less, and in 1881 pigeon hunting, as a business, died out. The ornithologist, Bendire, writing in 1892, at length said "....it looks now as if their total extermination might be accomplished within the present century." The flocks were now scattered; the birds no longer bred together, but in more or less isolated pairs. Soon they became extremely rare. Since 1898 there have been no well-authenticated and unquestioned records of their capture. A female, said to have been shot at Bar Harbor, Maine, in the summer of 1904, and to have been mounted by a taxidermist in Bangor, has not been traced and identified.

Does not this tale of millions of birds in 1800 and not one in 1915 bear the same warning as does that of the dodo? Both were valuable elements in the natural economy; both were numerous; both were sought by man for the same purpose; both were slaughtered in the same unrestricted fashion; and both are no more.



THE GOOD-NATURED BUT SLOTHFUL DODO

In the background of the picture can be seen sailors killing the birds with clubs and carrying them to the ship to be used for food



THE LATE PASSENGER PIGEON

The mourning dove, left, one of our common wild birds, is often mistaken for its relative, the now extinct passenger pigeon

NEW JERSEY ENTRANCE TO THE HUDSON RIVER BRIDGE

The Hudson River bridge, whose under side will be 200 feet above the river, strikes the perpendicular cliffs of the Palisades and passes through in a 50-foot cut, spanned by this monumental arch which forms a fitting portal to the bridge

A Monumental Bridge

New York Will Soon Possess Another "World's Greatest" in the 3500-foot Suspension Bridge Across the Hudson River

THIS is an age of superlatives, and it would sometimes seem that the ultimate word of praise has been bestowed when we are able to say that something is the longest, highest, fastest, biggest, et cetera, thing of its kind. So we are quite in the fashion in starting this article on the new Hudson River bridge, if we say at once that its span is so long, and its towers are so high, that it will be incomparably, on completion, the greatest suspension bridge, or bridge of any kind, for that matter, in the world.

The bridge is being built to provide greatly needed transit facilities between the northern part of Manhattan Island, the Bronx, Long Island, and New Jersey. At present, freight and passengers make the transit of the North River either by ferries or tunnels; and although the ferry service is excellent, and four separate tunnels, including the vehicular tunnel, are, or soon will be available, these are not sufficient to meet the present conditions, to say nothing of the vastly increased travel of the future.

The urge for a great Hudson River bridge has long been felt. It must now be some 40 years since that widely known bridge engineer, Gustav Linddenthal, startled the world with his bold proposition to bridge the Hudson with a great suspended structure, having a central span of about 3200 feet. Some years ago, due to the movement uptown of the centers of business activity, the site for the crossing was moved from 23rd Street to 59th Street.

The latest plans for this structure call for a bridge with a floor width of about 230 feet and a capacity for 16 lines of motor-car traffic on the upper deck and 12 tracks for steam and electric trains on the lower deck. The scheme contemplates a large railway terminal at the Manhattan end of the bridge, and an elevated structure crossing Manhattan at 59th Street, designed to give direct motor-truck and rapid-transit connections with Long Island.

VARIOUS considerations, including the great cost of the enterprise, have delayed its construction; but there is no question but that the rapid growth of the metropolitan area and its freight and traffic demands will ultimately secure its completion.

Meanwhile, the Port Authority, acting under the mandate of the states of New York and New Jersey, has undertaken the construction, between Fort Washington and Fort Lee, of the great bridge which forms the subject of the present article. Its capacity will be much smaller than that of the proposed 59th Street bridge and its estimated cost of 50,000,000 dollars is of course proportionately less.

The bridge is to be built in two stages. When the first stage is completed, it will provide a single upper roadway for four lines of vehicular traffic and two passenger sidewalks. It is estimated that 50,000,000 dollars will cover the cost of this. Later, to meet the growth of population and travel, the upper or roadway deck is to be widened and a lower platform will be provided. The bridge, as thus finally completed, will provide for eight lines of vehicular travel and footwalks on the upper deck and for four or more lines of rapid transit tracks on the lower deck. The whole cost of the structure when finally completed will be about 75,000,000 dollars.

Work will be done, as we have said, under the direction of the Port of New York Authority, of which Geo. S. Silzer, former Governor of New Jersey, is Chairman. O. H. Ammann, formerly chief assistant engineer to Gustav Lindenthal in the design and construction of the Hellgate bridge and the design of the 59th Street Hudson River bridge, is the bridge engineer responsible for the design and construction of the present structure. He is assisted by Wm. H. Burr, Geo. W. Goethals, Daniel E. Moran, and Leon S. Moissieff as consulting and advisory engineers.

It will be of interest here to touch upon the history of long-span bridges. The first and most notable of these is

the Brooklyn bridge, completed in 1883, a suspension structure with a clear river span of 1596 feet, carried by wire cables. Seven years later was built the famous cantilever, Firth of Forth bridge in Scotland, which includes two cantilever spans each 1710 feet in length. This dimension was exceeded when there was opened, in 1917, the St. Lawrence cantilever bridge, near Quebec, with a central span of 1800 feet. Other notable bridges are two suspension structures across the East River, (the Williamsburg bridge with a 1600 foot span and the Manhattan bridge with a 1470 foot span); the Bear Mountain suspension bridge opened in 1924 with a central span of 1632 feet; and the Camden bridge across the Delaware, with a span of 1750 feet. This is today the longest suspension span to be found anywhere in the world.

THE Hudson River bridge will have a central span of 3500 feet, which is just twice the length of the Camden span. The total length from anchorage to anchorage will be 4800 feet, each of the shore spans being 650 feet in length from the main supporting towers to the anchorages. Necessarily, dimensions and weights in a structure of this vast size will run to large figures. The height of the towers above water will be 650 feet. The weight of the suspended structure will be 120,000 tons. The total maximum pull on the wire cables will be 135,000 tons, and, if eyebar cables are used, it will be 165,000 tons. The vertical load on the towers, if eyebars are used, will be 140,000 tons, and with wire cables it will be 115,000 tons. The total load on the foundations will be 350,000 tons.

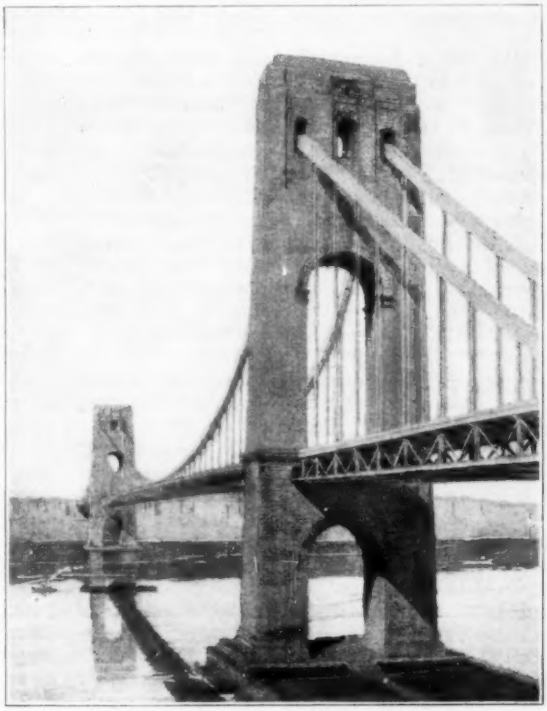
To resist the pull of the cables on the New York side, there will be built a vast, concrete anchorage weighing 370,000 tons. Finally, the total weight of the entire structure, including anchorages, towers, cables, floor system, et cetera, will be about 1,000,000 tons. These are enormous figures; but we must remember that they are for the two-deck structure as finally completed.

To come down to details, if eyebars are used, they would be made up in four cables each consisting of 48 eyebar chains, consisting of eyebars two inches thick by 16 inches deep and 60 feet or more in length. If wire cables are used, there will be four cables, each 36 inches in diameter. Each cable will be made up of 28,500 number six galvanized steel wires laid parallel, bunched snugly together by hydraulic pressure, and wrapped with a steel-wire protective covering.

That the cables will have a generous margin of strength is seen when we remember that the pull required to break a single wire is 6000 pounds, and that the pull on one wire, when the bridge is loaded to its maximum capacity is only 2300 pounds.

It will be understood that in a bridge of this great size the principal stresses are those due to the weight of the structure itself. So great is this, that the weight of the live load consisting of motor cars, trains and pedestrians is relatively small. This is not true of shorter suspension bridges, for in these, the weight of a moving train is in much larger proportion to the weight of the bridge.

When, several decades ago, Roebling built an 800-foot suspension railway bridge at Niagara, it was realized that as a train advanced over the bridge it would cause a local sagging of the cables so that a wave of depression would mark the transit of the train. This was overcome by incorporating a deep truss with the roadway. The Hudson River bridge, however, is so heavy, that a comparatively shallow truss will suffice to prevent vertical distortion of the roadway. It is claimed, and we think with good reason, that the small depth of the truss adds greatly to the artistic or esthetic appearance of the bridge.



SPANNING THE HUDSON

Perspective of the monumental bridge which will sweep from shore to shore in one unbroken span of 3500 feet

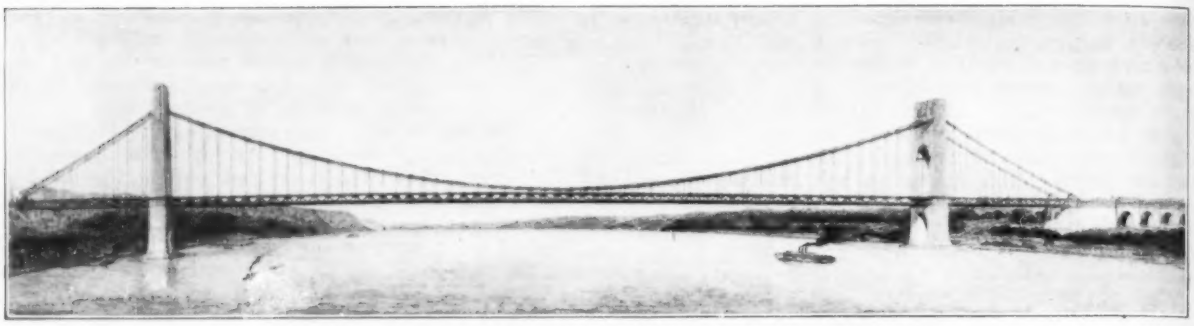
Construction in two stages will conduce to the early opening of the bridge, and it will be necessary to find only 75 percent of its ultimate cost for the completion of the first stage.

As thus carried out, the bridge will consist of the two anchorages, the complete cables, and the two 650-foot main towers, which will be built of steel. The single deck will provide, at first, for four lines of vehicular traffic and two passenger footways. When the time comes to provide for rapid transit tracks, a lower deck will be constructed on the level of the lower chord of the stiffening truss. To provide for this additional load, and to enhance the appearance of the structure, the towers will be strengthened by enclosing the original steel structure of the bridge in a mass of reinforced concrete. The towers will be faced with granite.

ON the New York side, the anchorage will consist, as we have stated, of a mass of granite-faced concrete of sufficient weight to resist the enormous pull of the cables. The approach to the bridge on this side will consist of massive masonry arches finished in cut granite, as shown in our general view of the bridge. On the New Jersey side, the floor of the bridge strikes the great natural wall of the Palisades at a point about 50 feet below its crest, and the roadway will pass through the Palisades in a cut of this depth.

In order to preserve the crest line of the Palisades, a masonry bridge, consisting of a central arch for vehicular traffic and two flanking smaller arches for pedestrian traffic will be carried across the cut. It will be of massive appearance and will form a fitting portal for the approach to the great bridge on the New Jersey side. The anchorages for the cables will consist of a tunnel driven for 250 feet into the solid rock of the Palisades, through which the cables will pass to take hold of a massive steel grillage embedded in the rock. These tunnels will subsequently be filled in with concrete, the whole work thus forming a thoroughly protected and permanent anchorage, secured forever against any accident, or deterioration due to the action of the atmosphere.

The architectural features of the bridge have been taken care of by Mr. Cass Gilbert who designed the Woolworth tower and many other monumental buildings in this city and elsewhere. He has endeavored, and we think very successfully, to treat the



VIEW OF THE HUDSON RIVER BRIDGE LOOKING UPSTREAM

The longest existing suspension span today is the crossing of the Delaware between Philadelphia and Camden, whose central span measures 1750 feet between towers. The span of the Hudson River bridge will be exactly twice as long, measuring 3500 feet. Height of towers 650 feet

great anchorages, and particularly the enormous towers, with that simplicity of line and sparing use of decorative details which a structure of this size demands.

Each tower will present the appearance of a single monolithic mass pierced by two wide arches, one below and one above the roadway. The cables will pass through small arched openings near the top of the towers. The vast proportions of these structures will be realized when it is stated that it would be possible to place a 17-story office building within the major arch over the roadway.

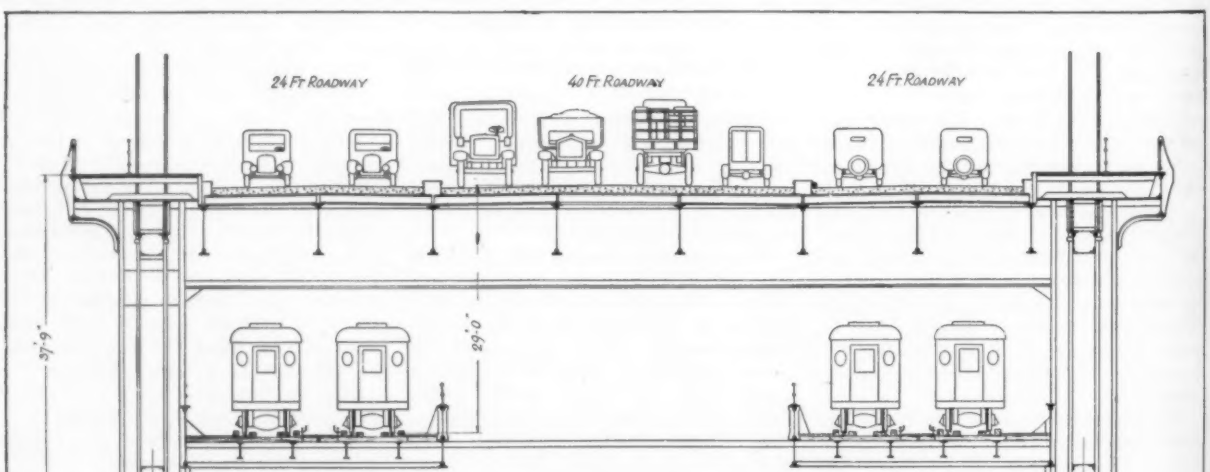
On the New Jersey side, good foundation rock for the tower is found at about 100 feet below water level. The excavation for this foundation will be done by means of two open cofferdams. Upon the New York side, rock of excellent bearing quality is found at the surface.

The Hudson River bridge stands in an exposed position and it will be subject at times to winds of high velocity. To resist the wind pressure, there will be a horizontal wind truss worked into the upper floor of the bridge; but the principal resistance will be found in the enormous inertia of the bridge itself. This is so great that if the bridge were struck by a furious gust, such as might come in a thunderstorm, its force would be spent before the bridge moved appreciably in response to it. The high improbable *continuous* force of a strong wind would push the center of the bridge not more than 12 to 18 inches away from normal.

IN the design, a maximum lateral swing of 3 to 5 feet has been provided for. There will be vertical distortion, however, due to the fact that the steel cables will shorten up about four feet in cold weather and will expand in hot weather, with the result that the center of the bridge will be about five feet higher on a cold day than on a hot day.

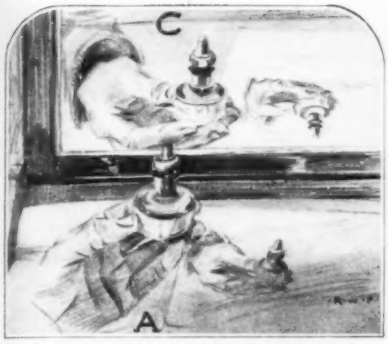
Finally, there is the question of future traffic over the bridge. It is believed that in the first year (1932) after the bridge is opened, the number of vehicles which will use the bridge will be 8,848,000 and that they will carry as passengers 18,898,000 people. The number of pedestrians is estimated at 1,413,000 and the number of buses which will use the bridge is put down at 497,000. It is believed that about 30 years later, in 1960, over 16,000,000 vehicles will carry some 50,000,000 passengers over the bridge, that among the vehicles will be 1,616,000 buses, and that the number of pedestrians will be over 3,000,000.

Outside of constructing the bridge is the problem of building adequate highways on the New Jersey side to carry away from the bridge-head and distribute the heavy traffic which will flow over the bridge. Many of these highways do not now exist. None of them have at present the capacity required. This means that they must be built *de novo*, or must be materially widened. It is estimated that the road-building program confronting Bergen County within the next decade will cost ten millions of dollars. There is no such problem at the New York end.



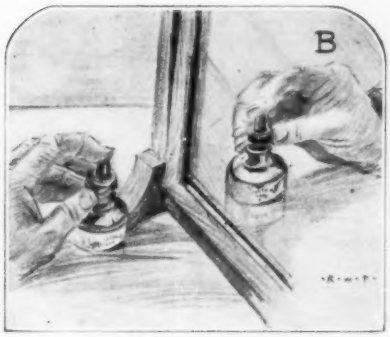
THE TWO-DECK FLOOR SYSTEM

The floor is hung by pairs of steel-wire suspenders from four 36-inch wire cables. On the upper deck is accommodation for eight lines of motorized traffic. This deck is carried on transverse floor beams about 10 feet deep, spaced 60 feet apart. Lower deck carries four rapid transit tracks



SOMETHING TO FIGURE OUT

FIGURE 1: *Why is image C perverted and the small drawing on chiffonier inverted?*

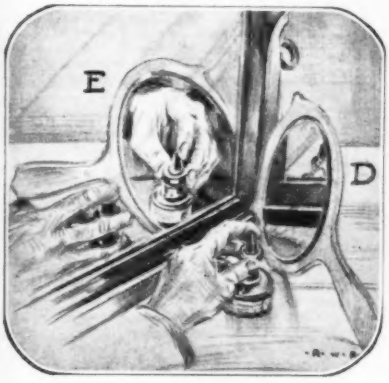


THE NEXT STEP

FIGURE 2: *By turning the hand as shown a right-hand reflection is obtained*

COMBINING THE TWO

FIGURE 3: *The hand of the first sketch is combined with the image in the second*



A SIMPLE "DODGE"

FIGURE 4 *Thus far we have obtained the picture as it appears to ourself; now we must do to it something which will make it look as it looks to the other fellow. A second mirror is therefore hunted up and placed as shown at D*

THE FINAL RESULT

FIGURE 5: *The image produced with the extra mirror (see E of sketch at left) is combined with image C of the first sketch, and we come out with just what we originally sought—the pose, not as it looks to us, but as it appears to the other fellow*

A Simple Study in Optics

By RUSSELL W. PORTER

"O wad some power the giftie gie us,
To see ourselves as others see us!"

"All right," you say, "Nothing easier—go and get the looking glass. . . . . There you are, just as others see you, on the other side of the mirror."

But the fellow I see in the looking glass has become so familiar that I forget the fact that he is not like me at all. It is only when we try on our new suit of clothes at the tailors, where he rigs up two mirrors, that we see ourselves as we actually are.

For example, your left eye in the glass doesn't look like a left eye. When you wink your left eye the fellow winks back with his right. Twiddle your right thumb: he replies with his left.

I referred the above statement to my daughter for verification. "Sure," she said, "I know that. Whenever I pin a flower on my dress I see which side it looks best on in the glass, and then I pin it on the other."

So that image on the other side of the mirror is very much like the animal that lived on a hill side which was so steep that his right legs became very much longer than his left ones, and the only way by which he could elude his pursuers was to turn himself wrong side out. By doing this his right legs became left and his left legs right, and he could travel in the other direction.

Now what has all this to do with science? What is it doing in the columns of the SCIENTIFIC AMERICAN? Well, nothing; except that it illustrates a fundamental property in optics, namely, that a reflected image is "perverted," as the highbrows say—or turned around. Not inverted, for the fellow is still right side up. And herein lies an application of light that I, as an artist, find very useful.

WHEN a person wishes to put an idea over, so that the other fellow sees it as he does, there is nothing in the vehicle of words that compares in realism and clarity with a sketch or drawing. Inventors (and their draftsmen) are sometimes hard put to it to express their ideas on paper. Here is an illustration:

Suppose I wished to show you (and you were not with me) some particular way of uncorking a bottle. I, being a draftsman, attempt the drawing. Of course the photographer could be called in, and that would settle it right away. But that procedure would take away most of the fun. I have only two hands and one of them is busy with the pencil. The left hand must do all the posing. But how? Simply by means of mirrors and multiple reflections, as follows:

If I want my friend to see the manner of uncorking the bottle as I myself see it, the left-hand pose is drawn directly, like A, Figure 1. Then, by looking in one of the mirrors I see my left hand, but it is a perverted image of it, and looks like a right hand. By getting a sidewise view and assuming the right-hand pose, this reflected image B, Figure 2, is drawn, and we get the view in the finished drawing, that is, Figure 3 as seen by the person himself who is doing the uncorking.

To present the picture as seen by the other fellow, the procedure is not so simple. The left hand is first drawn by reflection, as seen at C, Figure 1. It looks like a person's right hand as you face him. My wife's hand glass is next requisitioned and set up as at D, Figure 4.

Now in the larger mirror one can see the hand glass, and in the hand glass is an image E, Figure 4, twice reflected, which has all the appearance of a person's left hand as seen when you face him. And it only remains to combine the two drawings C and E to have the complete sketch, Figure 5.

THE RECORDING INSTRUMENT

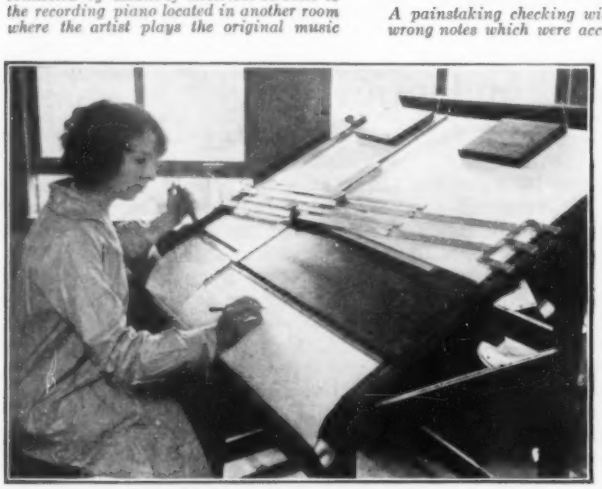
The record of the notes and tone coloring are taken down on the right-hand sheet in the form of pencil marks. The dynamic record, on the left, comes off the instrument without anything showing on the sheet. After it is put through a development process, marks indicating the measurement appear. These marks are then identified into pairs which are measured by a scale divided into one hundred and twenty parts; each part represents one-tenth of the difference in loudness discernible by the average ear. After this is done the measurements are transferred to the note sheet giving a figure at the beginning of each note which tells to an unbelievable accuracy just how loud that note was struck by the recording artist. The recording instrument is connected by means of electrical circuits to the recording piano located in another room where the artist plays the original music

WRONG NOTES ARE ELIMINATED

A painstaking checking with the sheet music eliminates wrong notes which were accidentally struck by the pianist

EVERY DETAIL IS MEASURED

Here the myriad dots and lines of the recording are examined and measured in the process of translating them into music-roll perforations which control the reproducing mechanism in the piano, and give a performance which clearly possesses even the emotional qualities of the original playing. Operators examine and measure every detail set down in the recording of a person's playing. One of the most interesting operations is the analysis of the tone quality which is made possible by indications showing the speed with which the dampers move up and down in the operation of the damper pedal. The reproduction of "half pedaling" and other subtle tone effects is made possible by a system of extending certain note perforations, which cause their tones to sing through from one harmony to the next, thereby giving effects identical with those which the original artist contrived to put into his playing



TRANSFERRING MEASUREMENTS

Unraveling the maze of figures in a dynamic record and transferring them to the roll is made extremely simple by an ingenious device

HAND PERFORATING PILOT HOLES

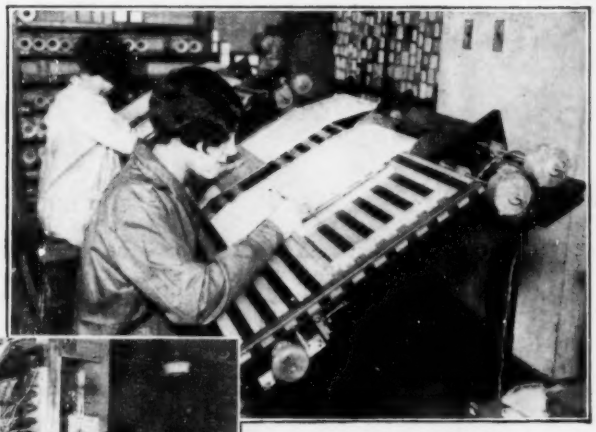
Hand-perforated holes at each end of the line indicating the position and duration of the notes guide the automatic stencil-making machine

Recording the Soul of Piano Playing

A RECORDING instrument, lately perfected by the Ampico Research Laboratory, accurately reveals the physical basis of those finer emotional qualities which mark the inspired performances of the great masters. A record taken on this instrument of the playing of an everyday pianist clearly shows the mediocrity of his performance as compared with that of one of the foremost great artists. That lovely liquid singing quality of tone—which is so rarely heard even in the great recital halls; that bel canto which subdues an audience to the point of making them regard the dropping of a pin as a misdemeanor; and a cough as a states prison offence; and other effects, heretofore regarded almost as manifestations of the soul of the artist, are being analyzed for mechanical reproduction through the record music roll. This delicate recording instrument measures accurately the length of time it takes the hammer to travel the last eighth of an inch before it strikes the string, and from this measurement the exact loudness of the tone produced can be easily calculated, 416 hundred-thousandths of a second being required to produce the softest note and 51 hundred-thousandths for the loudest. About 60 times more energy therefore is expended in striking the loudest note than when producing a whispered pianissimo. Some

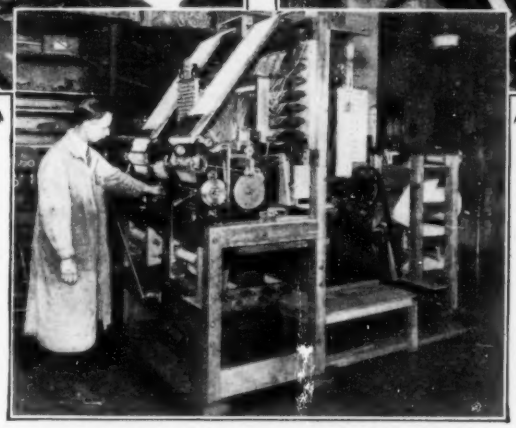
FIRST HEARING OF RECORD

The first time a record is heard is when it comes from the automatic stencil-making machine. With only pilot perforations at the beginning and end of each note as guides, this machine has simultaneously cut a trial and a finished stencil. The stencil is three times the length of the trial record. An operator who is a finished musician takes the record at this stage and carefully examines every detail of the performance, checking up the result of the various stages in the long process of its completion. After the corrections indicated during this rigid inspection have been made, the record is an exact duplicate of the artist's playing, even in the smallest detail of light and shade, and is now ready for the artist to hear. Upon hearing the record, the artist becomes his own critic and if any further change is to be made, it is in deference to his wish to alter his performance



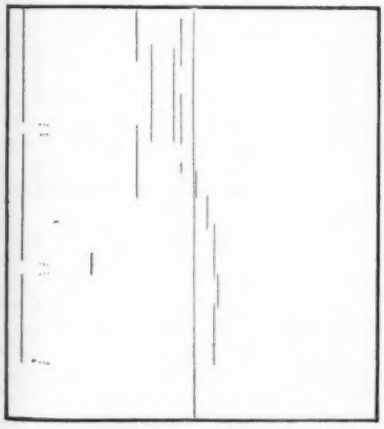
STENCIL CHANGES

A special table over which the record and the stencil pass at the right proportionate speeds facilitates the making of any changes in the stencil which the artist has indicated in the record after hearing its performance. Usually the changes suggested by an artist have to do with dynamic where he accented a note too much or too little or where one phase had too much or too little contrast with another. He seldom touches the rhythm or the tone coloring. In a dance record, the rhythm is automatically checked and corrected in the stencil machine. After alterations are made the machine makes duplicates from this stencil and these in turn are used in the manufacture of the finished music rolls used in the reproducing piano. The actual music-cutting machines are duplex, cutting 30 rolls at a time in two groups of 15 each at the rate of three and one-half feet of finished record per minute of operation



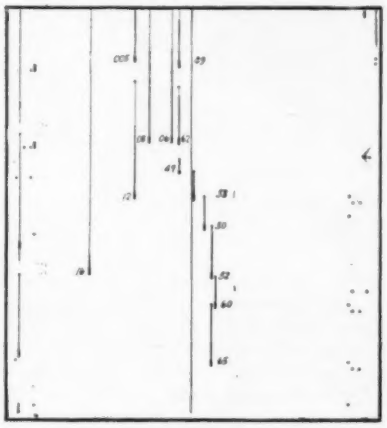
AUTOMATIC STENCIL MACHINE

This remarkable piece of automatic mechanism, which all but thinks, took more than five years to design and construct



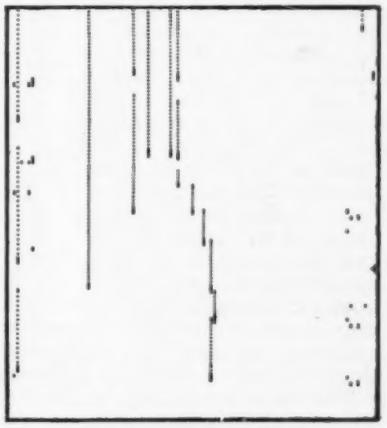
ORIGINAL RECORDING

Here are shown the pencilled lines of the notes, pedaling, and speed of the dampers



COMPLETED MASTER

It has the dynamic figures, tone coloring extensions and expression perforations



FINISHED PRODUCT

The record as it comes from automatic stencil machine, ready for first hearing

Revealing Idiosyncrasies of Artists

interesting side-lights are shown in the playing of great pianists by this super-accurate method of recording. One artist who produced an exceptionally beautiful quality of singing tone was found to co-ordinate his hands and pedaling to the almost incredible accuracy of one fiftieth of a second. We sometimes hear a performance which sounds perfect. Apparently there is not a flaw existing in the playing. Records of such performances when analyzed sometimes reveal unbelievable faults. One example, which to the ear showed the most remarkable control of dynamics, beautifully graduated melody, and an accompaniment played with almost inaudible softness and smoothness, revealed when submitted to the tests of an uncompromising measuring machine, a grossly faulty rhythm in the accompaniment. This shortcoming was not discernible in listening to the playing because the accompaniment was too soft to define the positions of the various notes. The records measure technical ability with uncanny accuracy. The marks of the pencil points of this soul-searching machine show exactly the control the pianist has over his fingers; whether his dynamics are nicely balanced or ragged; if his tone is good or bad; and even whether his playing has feeling or is cold. The performance is figuratively put under a microscope.

What is New in Radio?

Manufacturers Turn to the Light-Socket Receiver— Many Improved Devices

By ORRIN E. DUNLAP, Jr.

RADIO this season is in a transition period. The autumn styles reveal a distinct trend from the battery-operated receiver to the light-socket set, which dispenses with all batteries and takes its power from the house-lighting mains. A few circuits of this type appeared on the market last year, but this season many more manufacturers have introduced batteryless equipment, because of the further development of alternating-current tubes and improved rectifiers. The filaments of the new tubes obtain their source of power from the light socket through a small step-down transformer, while the rectifier tubes convert the alternating to direct current at suitable voltages to replace "B" batteries.

THE round dial, which was the standard tuning scale up to about a year ago, has been eliminated entirely from the majority of new sets. Most of the manufacturers have adopted the drum control arrangement, featuring a tiny "window" or slit in the panel, through which the wavelength figures appear as the stations are tuned in. The single control for tuning is extremely popular on the new models. A small knob is used generally to manipulate the drum-tuner, which adjusts the variable condensers arranged on a single shaft, thereby affording simplicity in tuning.

The table models, on an average, are smaller and more compact than have been previous instruments. However, each manufacturer usually supplements the smaller sets with more elaborate console cabinets with the loudspeaker built in, while some apparently favor the external loudspeaker arrangement. In exterior appearance, the table models have a marked similarity, probably due to the fact that there cannot be a wide variety of arrangements of a single tuning control. Cabinets in general are of the slanting panel design, so that light will more easily fall on the tuning "window," usually placed in the center of the panel. Some of the sets feature pressed-steel chassis upon which the various parts of the circuit are firmly mounted, with tubes, transformers and coils shielded in metal compartments.

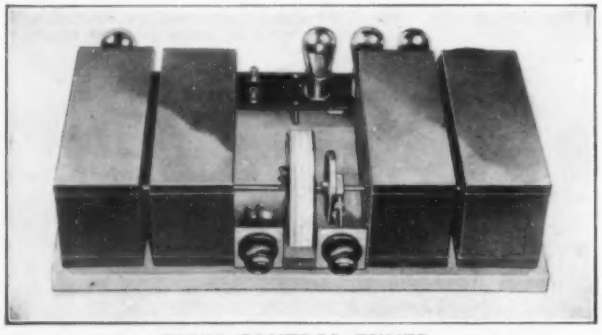
In the loudspeaker field the cone predominates. The horns are not as plentiful as they were several years ago. They are vanishing as did the horn of the early phonographs. Some of the disks have plain faces, while others have a decoration of some sort.

A NUMBER of cone reproducers are built in small cabinets to match various furniture designs. Others are drum or clock-shape. One novel loudspeaker of the cone type is built within a library globe, hinged at the center on its bronze pedestal, so that, by tilting back the upper half or closing the top to complete the sphere the volume of sound can be regulated. It is pointed out that this design gives the radio fan a handy map on which he can locate broadcasting stations or trace events that are broadcast, such as the progress of transatlantic airplane flights.

Radio set owners desirous of converting their present battery-operated receiver into one which functions in connection with the light socket will find a large assortment of "B" eliminators; trickle chargers with storage "A" batteries; also combination "B" eliminators and power amplifiers, the output of which

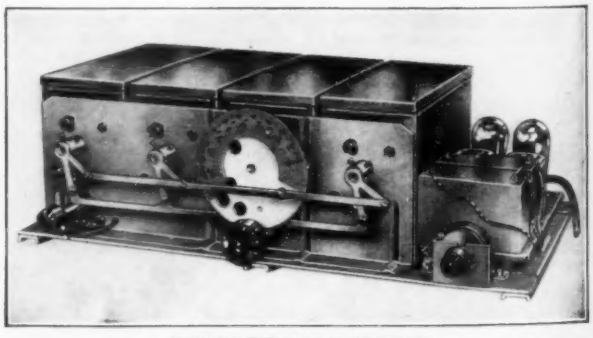
FLEXIBLE RECEIVER

This Crosley set is designed so that it can be transferred without changes from a standard table model cabinet to a console. A screw driver is the only tool necessary for making the change



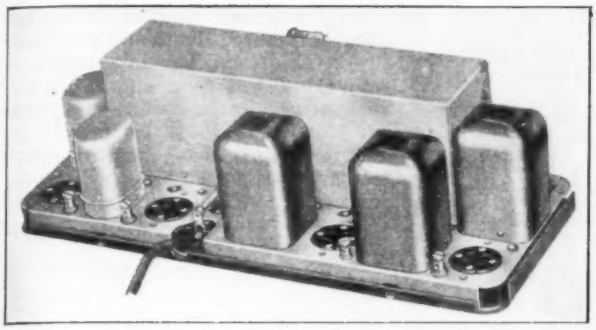
DRUM CONTROL TUNER

Chassis of the Workrite receiver, showing how the condensers and coils are shielded by means of metal cans, thus eliminating many undesirable effects. Tuning is done by a single control



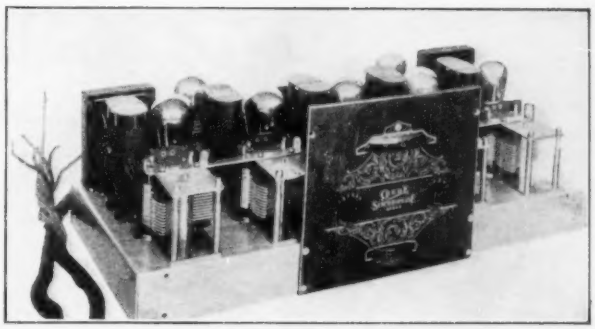
COMPLETELY SHIELDED

Metal cans enclose all of the essential parts of this Stewart-Warner set, affording complete shielding. Note the novel lever arrangement that is used in order to effect single control



THE "BANDBOX" SET

This is a rear view of the receiver illustrated in the center of the opposite page. Every part of it is completely shielded



SINGLE CONTROL

One of the new styles in radio designs, in which are featured binocular coils which, with the other parts, are on a metal base

can be regulated from a whisper to volume sufficient to fill a large auditorium with minimum distortion. These combination units plug into the circuit after the first audio-amplifier stage and therefore can be utilized to excellent advantage even with a two-tube set. Most of the current-supply apparatus employs new and improved rectifier tubes and in several instances the devices dispense with "A", "B" and "C" batteries by supplying the current to the receiver direct from the house lighting mains.

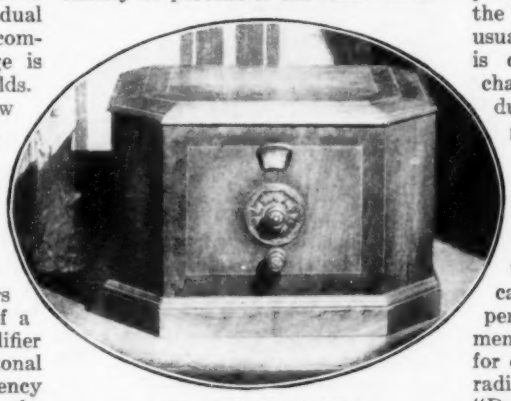
SIX and seven tubes in the circuit are popular numbers. The engineers have been careful to shield the tuning coils in most cases so that there will be no interaction to produce non-selective tuning or loss in signal intensity. Some have gone so far as to encase each coil in an individual cylindrical metal box, and each complete tuned radio-frequency stage is protected by rectangular shields. Several of these sets use the new alternating-current tubes and operate in direct connection with the light socket without the necessity of current-supply accessories.

The tuned radio-frequency circuit is most generally employed, and there are very few designers who have not taken advantage of a power tube in the last audio-amplifier socket as a means of improving tonal quality. There seems to be a tendency this season to get away from the external loop. Wherever loops are used they are usually advertised as "concealed," because it is said that housewives nine times out of ten vote against a receiver equipped with a visible loop. They say that it is not decorative and is not attractive in a living room.

It is contended that the majority of people have never installed a radio set in their homes because they do not want to bother with battery replacements and charging. Now, the manufacturers say that the light-socket receiver is here and that 11,923,060 homes wired for electricity, but without radio, can be equipped with foolproof sets. It is estimated that 6,500,000 homes have radio sets. The figure for 1930 is placed at 9,000,000.

The fact that numerous styles of light-socket receivers will be introduced this season does not mean that there will be no new sets designed for battery operation. There are plenty of high-class receivers built to perform with batteries or battery eliminators. Neither does the appearance of new alternating-current tubes mean that all sets now in use are obsolete. There are no vacuum-tube circuits which cannot be converted for light-socket operation by employing the various current-supply devices.

A survey of the exhibits at the Radio World's Fair, held in Madison Square Garden, N.Y.C., revealed that approximately 30 percent of the receivers this season are designed to operate with alternating-current tubes. Seventy percent are battery operated. However, comment by the various exhibitors disclosed that most of them are in agreement that the percentage of electrical sets will increase from year to year, chiefly because of the millions of homes wired for electricity and the general desire of radio set owners to have light-socket receivers. Nevertheless, it is not anticipated that the evolution from the battery-operated set to the power-socket instrument will be as rapid as from the crystal to the vacuum tube in the early days of broadcasting.



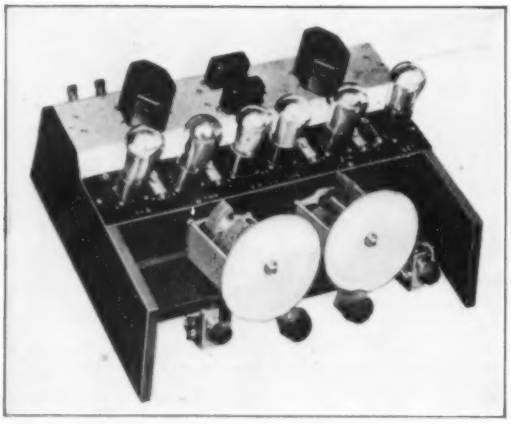
NEW RADIO STYLE

The construction of this new Splitdorf six-tube receiver clearly illustrates the trend in radio toward single control and the "window" method of reading the dial settings instead of the old type of round dials

The number of receivers of the table and console type is about evenly divided. The manufacturer who produces a console usually offers the same circuit in a table model or consolette. About 15 percent of the consoles have built-in cone loudspeakers, while 60 percent use the built-in horn with a long air column ranging from 50 to 70 inches in length. The remainder of the consoles are designed for use with external loudspeakers.

IN the loudspeaker exhibits this fall, about 75 percent are cones. Competition is now between the cone and the long air column composition horn, usually made of plaster of Paris. It is contended that the lengthy air chamber enables the horn to reproduce the lower notes equally as good as the middle and higher registers.

A review of the booklets and pamphlets, slogans and comments at the Radio World's Fair shows what is offered and what radio buyers this season can expect to obtain for their expenditures: "Unbelievable improvements in performance;" "A set priced for every pocket book;" "Battery-less radio;" "Stability as to patents;" "Durable, foolproof, shielded and sealed;" "—for the first time you can obtain from your house-lighting current steady, uniform flow of radio energy;" "Everybody agrees this is an electric set year;" "To connect a cheap loudspeaker to a fine radio set is like asking an opera star to sing through his nose;" "You can't get far away from the quality of the tube itself;" "This is an 'A. C.' year;" "Drum notes not only heard but identified;" "Totally shielded;" "Tubes for every purpose;" "Full rich tone;" "The world at your finger tips;" "Single control;" "A 'missing' tube in your set is even worse than a 'missing'



CHASSIS OF "COUNTERPHASE"

Some two years or so ago, an improved circuit known as the Bremer-Tully "Counterphase" made its appearance. Immediately it was seized upon by experimenters and subjected to exhaustive tests. The circuit proved to be highly satisfactory in many respects and has since been modified and changed slightly to give the best possible results. Here we see the entire set in its new form for the 1927-1928 season. It employs six tubes and has two tuning controls, the calibration figures of which are viewed through "windows" in the panel

cylinder in your car;" "Electric sets as different as electric light is from a candle;" "Always at full power;" "Extraordinary selectivity;" "A new achievement in power unit engineering;" "Harmonated reception;" "No hum;" "Wonderful range;" "Radio is better with battery power;" "Laboratory precision;" and thus one might go on and on describing the autumn styles, but these words of the men behind the apparatus give an excellent idea of what can be looked for in the new instruments.

THE accessory field is the outlet for numerous novelties. One company is offering a permanent ground constructed of a solid copper sheet rolled in the form of a truncated cone. It is four inches in diameter at the base and three inches at the top. The height is twelve inches. It is filled with pebbly charcoal to hold moisture. The top is detachable. A 20-foot insulated copper wire welded to the "ground" is provided for attachment to the receiver.

A novel radio log listing more than 500 broadcasters in the wave band from 200 to 546 meters is being marketed by a Chicago concern. The log is published five times a year and is gummed for mounting on a revolving cylinder measuring about six inches long. It can be placed on top of the receiver or hung on the wall. Revisions are supplied on a subscription basis.

NEW TUBE

This is the type of tube used in the Kellogg receiver illustrated above. The filament terminals are at the top of the tube, while the connections for the grid and plate come out at the base to tips of the usual type. This tube can be plugged into a standard socket

A time-signal amplifier has been introduced to the autumn trade. It is called a "jeweler's time amplifier," consisting of a three-stage long-wave amplifier and detector completely encased in a copper shield with only the tops of the four tubes protruding. The unit is pretuned at the factory to the 112 kilocycle frequency used by the United States Navy's transmitter NAA at Arlington, Virginia, in radiating the time ticks of the nation's master clock located in the subterranean vault of the Naval Observatory at Washington, D. C.

The phonovox is an electrical pick-up designed to convert an ordinary phonograph into an electrical one, by utilizing the audio-frequency amplification and reproducer system of a standard radio receiver. The device is attached to the tone arm of the phonograph, while an adapter fits into the detector socket in place of the tube.

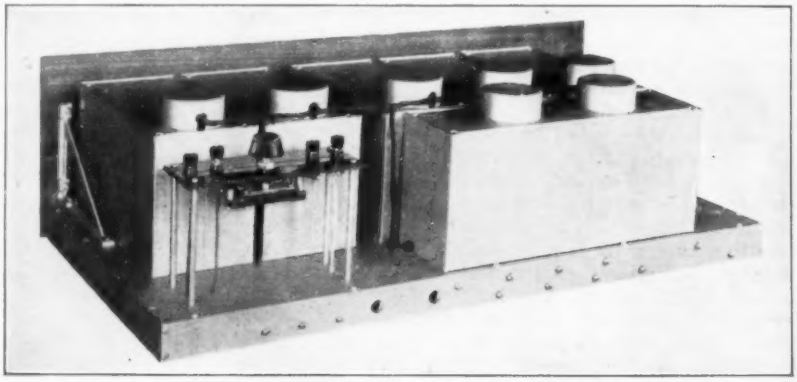
An instrument for reactivating and testing worn-out vacuum tubes has been introduced by a manufacturer in Massachusetts. The device operates from 110 volt, 60-cycle, alternating current and requires no batteries. Sockets are provided in which the correct voltages for testing, flashing and "cooking" thoriated tungsten filaments are automatically obtained without adjustments. It will test oxide-coated filaments too.

A new type of vacuum tube designed as an oscillator for short-wave transmission has been announced by a concern in New Jersey. It has an input of 300 watts and fits in the standard 50-watt tube socket. It will oscillate on a minimum wavelength of 2½ meters. As high as 2500 volts can be applied to the plate inasmuch as the plate terminals are at the top of the bulb, thereby eliminating danger of a short circuit in the form of a flash-over.

A New York manufacturer has introduced a cone speaker which can be utilized as a small table having a top 18 inches in diameter. It is made in two-tone mahogany with the cone mounted so that the wooden casing is used as the table top and sounding board.

An Indiana concern offers a star-shaped antenna said to be non-directional. It consists of a cast of aluminum ten inches across the tips and three-quarters of an inch thick. It is mounted on a ten-foot electric conduit pipe from which the star is insulated by a three-inch bar. The lead-in wire is taken off the center on the back of the star.

A Detroit manufacturer has developed an automobile bumper to be used as an antenna for radio reception in a motor car. By means of insulated laminated strips the bumper antenna is carefully insulated from the chassis of the car. A special clamp is employed in holding the bumper to insure good electrical contact. The ground or counterpoise contact is made to the body of the car.



MODERN BATTERYLESS RADIO CONSTRUCTION

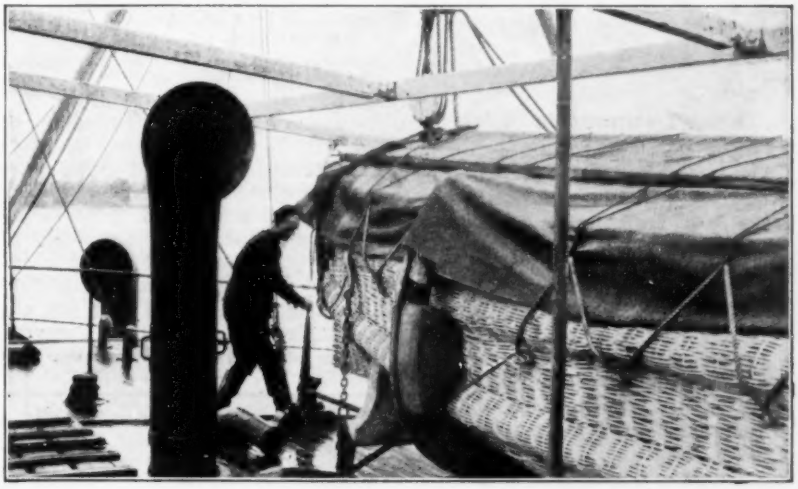
This Kellogg light-socket operated receiver uses alternating current tubes of the type illustrated below. The filaments are operated directly from stepped-down house current. No batteries are required. Notice how all of the various parts and circuits are shielded from each other by metal cans

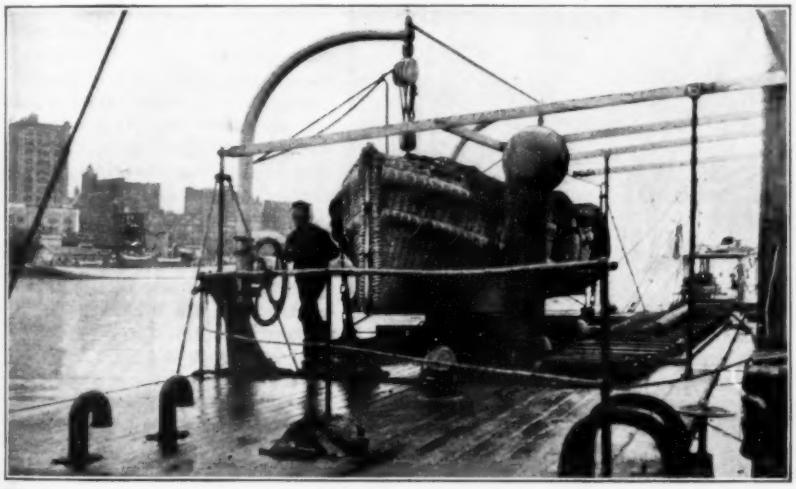
Life-boats Made Safer

Dutch Patents Cover New Type of Construction

RELEASING THE BOAT

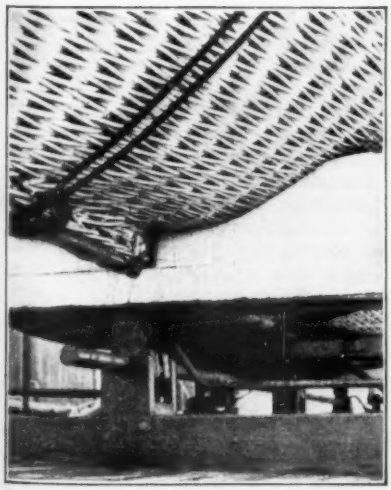
THE method of swinging this new life-boat away from the ship so that it can be lowered to the water is simplicity itself. A releasing lever, shown in operation here, drops the supporting chocks, leaving the boat free to swing on the davits. These safety life-boats are, as far as the inner frame-work is concerned, of ordinary construction. The base over which the "basket-work," plainly seen in these photographs, is applied is a life-boat of the usual type. However, the exterior is covered with a heavy layer of firmly woven reed which serves to increase buoyancy and at the same time protect the boat itself from injury. When the boat is in need of painting, the paint is applied directly to the reed. The two long bulges contain cork to aid floatation.





LOWERING THE BOAT

AFTER the lever illustrated above has been pulled and the chocks have fallen away, turning of the hand wheel as shown at the left swings the boat out into position for easy lowering. The hand wheel is connected to a horizontal gear wheel on the forward davit by means of a worm. The davits are so spaced and connected at their heads by a steel bar that the boat is rigged right out into position for lowering without any trouble. In this photograph the bulges containing cork are plainly visible on both sides of the craft. It was said by Captain Haak of the Dutch *S. S. Callistro*, on which these boats are installed, that he has launched boats of this type heavily loaded, yet not a drop of water entered. Boats somewhat similar to these were used during the World War.

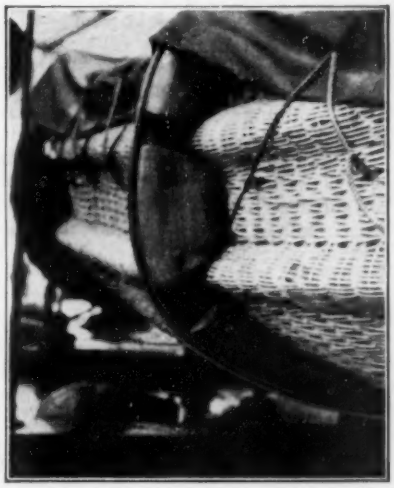


◄ THE RELEASING MECHANISM

WHEN the releasing lever, see upper photograph above, is operated, a sort of crankshaft is moved, causing the chocks that hold the boat in position to drop away and release the boat. This crankshaft and the chocks are plainly shown in the illustration at the left. At the same time the chains that hold the boat from swinging on the deck are loosened.

THE STEEL "TRACKS" ►

WHEN the boat is to be lowered from the high side of a vessel that is listing badly, it can slide down the side without catching on the laps or plates. This is made possible by the use of steel "tracks" or runners held on wooden blocks as shown. When the boat is in the water, these runners can be released so as not to impede motion of the boat in the water.



The Month In Medical Science

A Review and Commentary on Progress in the Medical and Surgical Field

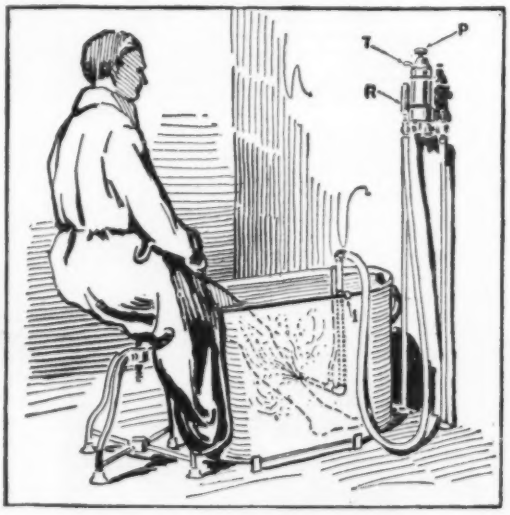
By MORRIS FISHBEIN, M. D.
Editor of the Journal of the American Medical Association *and of* Hygeia

Water Treatments in Disease

SINCE the time of Hippocrates, and perhaps long before that, water has been used in treating disease. Warm-water baths are sedative, cold presumably stimulating. Cold increases the elimination of carbon dioxide, whereas heat reduces it. Alternating hot and cold baths are invigorating. An indifferent bath with the temperature ranging from 94 to 95 degrees keeps the heat-regulating apparatus in equilibrium, and continuous baths of this temperature are regularly used in hospitals for the insane to quiet excited patients.

Carbonated or Nauheim baths started at a temperature of 92 degrees, Fahrenheit, are much used in treating patients with heart disease. Tney are believed to reduce the size of a dilated heart and to promote its contractile power. Such baths are available in Glen Springs and Saratoga Springs, New York, at Galen Hall in Atlantic City, and in the hospital of the University of Pennsylvania.

One of the most commonly used methods of treating painful joints or swollen limbs is the continuous whirlpool bath of a fixed temperature. The whirlpool bath originated in France and has been greatly improved by American inventive ingenuity. The temperatures range between 104 and 120 degrees; air under pressure is introduced below the surface of the water, which is given a swirling motion as water is mixed with air forced by the aerator. The duration of the bath varies from 40 to 45 minutes. It is much used in government hospitals when applying heat to stiff joints. The army authorities do not recommend it for inflamed joints or for conditions in which the nerves are involved. Other authorities recommend its use for fractures and sprains and for treating flat feet and chilblains.



A "WHIRLPOOL" LEG BATH

Air from a pressure tank is introduced below the surface of the water, causing a swirling motion

The Number of Red Blood Cells in the Human Body

EVER since the red blood cells were first seen in the circulating blood more than 100 years ago, scientists have been endeavoring to determine such facts as the amount of blood flowing in the veins and in the arteries of the average person and the number of red blood cells. Indeed, accurate measurements of temperature, pulse rate, breathing rate and other measurable factors are of the greatest importance in measuring the extent or nature of disease. Obviously all of these determinations are subject to human error associated with the one who makes the observations and with defects of apparatus that is used for making of the important measurements.

The number of red blood cells is important particularly in relationship to such diseases as pernicious and secondary anemias. When the number is considerably below 4,500,000 per cubic milimeter, the person is likely to breathe with difficulty and have little vitality or resistance to disease. In a figure as large as 5,000,000, a variation of 10,000 does not make a considerable difference. However, larger variations are of importance.

Recently Dr. C. D. Leake and his colleagues have taken samples of blood at hourly intervals from students 10 to 30 years of age. They find that the number of red blood cells may vary by 345,000 at various times during the day for men, and 310,000 for women. In the same way, the specific gravity of the blood varied by 0.0033 for men and 0.0027 for women, with general averages of 1.0565 and 1.0533. The determination of such variations is of the greatest importance in permitting a clinician to estimate changes in the patient's state and to interpret laboratory observations. A daily variation of as many as 315,000 cells is possible under normal conditions; variations of less than this amount need not be given great significance in relationship to disease.

Acidosis

A MODERN word with which to conjure in promoting all sorts of foods is acidosis, about which unfortunately there is much misunderstanding among the public as to the exact significance of the term. Obviously it means too much acid in the system, although as a matter of fact an acid reaction of the human body is incompatible with human life. The term, therefore, means that excessive amounts of acid substances other than carbonic acid are present in the body.

In the presence of acidosis, there is a decrease in the carbon dioxide and an increase in the hydrogen iron concentration of the blood. There is also a lessening of the carbon dioxide tension in the air that the person breathes out. It is possible to obtain evidence of the degree of acidosis by testing the excretions of the body, but these tests are not so reliable as those made on the blood. One of the simplest tests is to give a large amount of a substance like sodium bicarbonate, or baking soda, which is alkaline, and to find out how much is needed in order to cause the excretions to give an alkaline reaction.

In the presence of acidosis, which is associated with various symptoms of distress, it is customary to prescribe alkalis like bicarbonate of soda and also to recommend the eating of fruits which tend to alkalinize the system. Such acid or acidulous fruits as apricots, cherries, lemons, quinces, strawberries, raspberries, gooseberries, oranges, grapefruit, peaches, apples, pears, plums and grapes contain free acids, but their alkaline acids are burned up in the system, giving rise to carbonic acid and are excess of alkali.

The Possible Bacterial Cause of Trachoma

THE infectious condition of the eyes associated with granulation of the lids and sometimes with loss of eyesight has long been the subject of investigation by physicians. The terrific extent of this disease among the Indians has been one of the major problems attacked by the United States Government in the care of this people. So serious indeed has this condition become, that the Japanese investigator, Hideyo Noguchi, of the Rockefeller Institute for Medical Research, was asked by the Department of the Interior to undertake an investigation of its cause in New Mexico.

Attempts were made to transmit the disease to apes by inoculation of material and to isolate various bacteria from the tissues. In his studies, Dr. Noguchi secured a micro-organism which he was able to grow in pure culture and with which he was able to induce a grandular inflammation of the eyelids similar to trachoma. The organism was found in four out of five cases carefully studied, and this organism only, among all of those isolated, produced the lesions in the eye of the monkey.

The evidence submitted by Dr. Noguchi was sufficiently strong to cause competent specialists in diseases of the eye to say that the burden of disproof lay on other investigators. In other words, they were inclined to believe that he had actually discovered the germ capable of causing inflammation of the eye similar to trachoma in the American Indian. As has been shown for many other diseases, the determination of the causative organism is the first step in complete prevention and control.

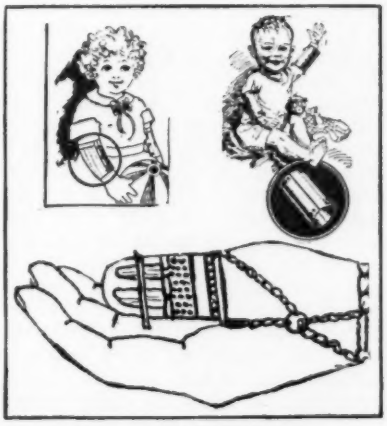
Thumb Suckers

THE Freudian or psychoanalyst of other schools is likely to insist that thumb sucking is associated with a secondary sexual disturbance of some sort and represents a desire of the child to return to its nursing period, perhaps an "unconscious desire." The mental hygienist objects to thumb sucking on the ground that it produces dream states in the child and delays its mental development. The dental hygienist asserts that it is a prolific source of malformation of the jaws and of the teeth and should be stopped for this reason, if for no other.

The specialists in diseases of children, in their attempts to overcome the habit, prescribe evil-tasting glues or other mixtures to be put upon the thumb to cultivate in the child a distaste for the process.

Many inventive geniuses have developed devices which make thumb sucking impossible, or at least so uncomfortable that the habit is abandoned. If the child is a girl, as she grows older and begins to appreciate the importance attached to nicely appearing fingers and finger nails, she is likely to abandon the habit for this reason only. Some people bring about a cure by systems of rewards and punishments.

The simplest device is a mailing tube of cardboard sufficiently large to put over the elbow as a cuff, which prevents bending the arms at the elbow, and thereby the possibility of putting the thumbs into the mouth. These can be homemade, but are also manufactured in various colors and with tapes for their attachment. Some persons apply adhesive tape in various configurations to the thumb and thus make its mastication undesirable to the infant.



ANTI THUMB-SUCKERS

Many mechanical devices have been made and patented with the point in view of stopping infants from sucking their thumbs. Three of these, the usages of which are obvious, are illustrated in the above drawing

The devices for thumb-sucking prevention are interminable and novel. Some of them are shown in the illustrations. If the child is old enough to understand and reason, an intelligent mother, and certainly an intelligent specialist in the care of children, will be able to wean the child early from the habit. For the younger infant, any one of the devices shown may prove successful.

Testing the Circulation

THE pulse rate has been used by physicians since the earliest times as a test of the nature of the circulation. More recently tests include determination of the rate while the person is lying down and while he is standing up. Attempts were made to find out whether the pulse responds promptly to exercise and the time is measured that is necessary for the pulse rate to return to normal after exercise. It is believed that a slow heart rate while lying down and standing up, with a small difference between the two, a slight acceleration of the heart rate in exercise with a quick return to normal afterward and a rise in the blood pressure on standing are excellent health signs. A person who responds correctly to these tests is then known to have a good blood circulatory system.

Recently, Dr. Abby H. Turner of the Harvard School of Public Health showed that even in healthy persons there is a fall in the circulatory minute volume on changing from a reclining position to a sitting or standing position. Apparently the circulation of the blood in the human being is not even yet perfectly adjusted to a standing position. Evolutionists recognize that many of the difficulties within the human system are due to the change from the four-footed to the erect posture.

In these studies it was found that the holding of a quiet standing position for several minutes is quite a difficult task for many people. Some persons whose blood circulation adapted itself readily to strenuous exercise found standing quietly a most difficult procedure. Persons who stand most easily and successfully are those in whom there is a slow heart beat and a relatively large pulse pressure. Persons who exercise without great stress on the circulation of the blood are also able to stand quietly for considerable periods of time without fatigue. In other words, the standing erect test is quite esily correlated with the other techniques for determining the quality of the circulation.

The Kahn Test and the Wassermann Test

IF any scientific diagnostic procedure is well established it is the Wassermann test for the detection of one of the most widely disseminated venereal diseases. So firmly has this procedure been established that almost any one can name the disease for which the test is used and its significance. It, therefore, becomes especially difficult to displace this procedure with any newer method, even admitting special qualifications for any such revised technique.

However, Dr. R. L. Kahn of the Michigan State Department of Health devised some years ago a precipitation test which has been gaining ground steadily in this country.

A recent report records the results in 300,000 cases of which more than 175,000 had been directly compared with Wassermann tests. These revealed the fact that the Kahn test is more sensitive than the Wassermann test both for the blood and for the spinal fluid. The advantages of the Kahn test are the use of cheaper material, and the lack of necessity for incubating the material over night. Thus the results of the tests may be determined within a period of a few minutes.

New Lights For Old

A Little Light on a Dark Subject

By H. AUSTIN TAYLOR
Assistant Professor of Chemistry, New York University

Silhouette of author photographed by light of phosphorescent background

THE cat and the owl have long been envied by man for their ability to see in the dark, or rather in what appears to man as dark. As a result, man has attempted to find means of aiding his normal vision. The most recent attempt in that direction appears in the form of small buttons, thumbtacks, or pendants which are capable of shining in the dark. The various luminous faces on watches and clocks are evidence, too, of this effort on man's part to assist his eyes during the darker periods of his existence.

This ability on the part of certain chemicals to give out light in an otherwise dark enclosure is classed by scientists under the general term of "phosphorescence." From all matter there is in some degree a response called forth when light shines upon it. The degree of response will depend on various factors—on the intensity of the light and its color, for example. The form of the response will differ, too, for different substances.

AS far as transmission of the light is concerned, glass is transparent, wood is opaque, while other materials show an intermediate transparency. Regarding these facts from the point of view of the material itself, the glass does not absorb the light at all, the wood shows complete absorption, while the intermediate substances show each a definite degree.

The question of interest in such a case is what happens to the light when it is absorbed. Light, we know, is merely one form which energy can take, just as is heat. A substance which absorbs light is therefore gaining energy, and when the light is removed it will tend to lose that energy and revert to its normal state. One form which this dissipation of energy may take is in an increased motion of the particles of which the matter is composed, an increased motion which evidences itself to our senses as heat. Another way that some bodies have of freeing themselves of the absorbed energy is simply to re-emit it. It is with this re-emission of absorbed energy that phosphorescence is concerned.

Phosphorescence may be a much more general phenomenon than we would at first realise. Not all light is visible to our eyes. There is beyond the visible region of the spectrum a far greater region of light to which our eyes are not sensitive, and consequently substances which emit their absorbed energy in that portion will not seem to be phosphorescing so long as we use our eyes as the measure of emitted light. To be of practical use such as for the purposes above mentioned the light emission must be in the visible region of the spectrum to which our eyes are sensitive.

In 1866 Sidot, a French chemist, was distilling a substance called zinc sulfide from a porcelain tube which was heated to redness in a furnace. The vapor of the sulfide escaping from the tube condensed on the colder walls of a receiver as small crystals which had the power of giving out a greenish light when viewed in a darkened room. This new phosphorescing form of zinc sulfide was so interesting that numerous attempts were then made to prepare it in large quantities. The preparation, however, proved a difficult task.

It was found first of all that zinc sulfide itself when absolutely pure could not be made to phosphoresce, even when heated strongly or even distilled. But immediately the smallest trace of some foreign metal such as copper became mixed with it, a subsequent heating gave a strongly phosphorescent sample. Furthermore, the color of the phosphorescence seemed to depend on this foreign metal.

This was a most startling result, since it has later been shown that the intensity of the phosphorescence as well as the color depends on the amount of this "impurity" and is extremely sensitive to it. One part of copper in a million parts of zinc sulfide is more than sufficient to cause a faint phosphorescence. As the amount of copper is increased, the brightness of the phosphorescence increases until, with one part of copper in 5000 parts of zinc sulfide, the maximum intensity is reached. Further addition of copper then causes a decrease in the brightness of the emitted light.

When manganese replaces copper as the "impurity," the color of the light which is emitted in the dark is orange, and the maximum intensity of phosphorescence requires from 10 to 50 times as much manganese as copper. This partly explains the difficulty of the preparation of phosphorescent bodies such as zinc sulfide. To be sure that just the right amount of "impurity" is present is a difficult task.

A FURTHER difficulty is connected with the heat treatment of the sulfide, which also is necessary. Zinc sulfide can exist in at least two crystalline forms. Just as carbon can exist as diamond and as graphite, so zinc sulfide can exist in two different crystalline forms one of which is known as sphalerite—more commonly as zinc blende; the other is known as wurtzite; of these only the wurtzite is phosphorescent.

This was shown recently by means of a very pretty experiment by Guntz, like Sidot, also a French chemist. Some zinc blende, which always contains traces of copper, was heated for a short time to allow some of the blende crystals to change into the wurtzite form. This mixed sample was then examined under the microscope (See figure). When viewed with a light shining on the surface the crystals of wurtzite stood out black against the white background of blende, but when the light was shut off the reverse was true because the wurtzite phosphoresced while the blende did not.

That seems to prove conclusively that only the one form of zinc sulfide can emit its absorbed energy as visible light. Now, since the wurtzite form can be obtained only from zinc blende by heating almost to fusion we see the necessity of the heat treatment.

Many other substances than zinc sulfide also have this power of phos-

PHOTOGRAPHS ITSELF

This picture, painted with multicolored phosphorescent paints, photographed itself

phorescing under certain conditions. Calcium sulfide, when exposed to light and then viewed in the dark, emits a distinct violet color. Barium and strontium sulfides too have each their own distinct phosphorescence which also depends on the "impurity" present. In these latter cases bismuth is the more generally added material.

Another very interesting fact concerned with phosphorescence is that its lifetime is quite definite under a fixed set of conditions. If we keep the luminous substance in a room at a fixed temperature and expose it to white light of fixed intensity for a few seconds and then shut off the light, the substance will glow quite brightly at first. But as time goes on the brightness decreases until eventually it is no longer visible—the phosphorescent light goes out. If we repeat the exposure to the exciting light under exactly the same conditions and for the same duration, the phosphorescent light remains visible for exactly the same length of time.

WE may alter this length of time during which the phosphorescence lasts by altering any of the conditions mentioned. For example if we raise the temperature, the phosphorescence does not last as long but seems to glow more brightly while it does last. Alternatively if we cool the substance we may make the phosphorescence last almost as long as we please, but again the brightness or intensity of the phosphorescence is decreased while it lasts. In fact, when we get down to the low temperatures attainable with liquid air the intensity of the phosphorescence is so weak that the substance is said to be no longer phosphorescent.

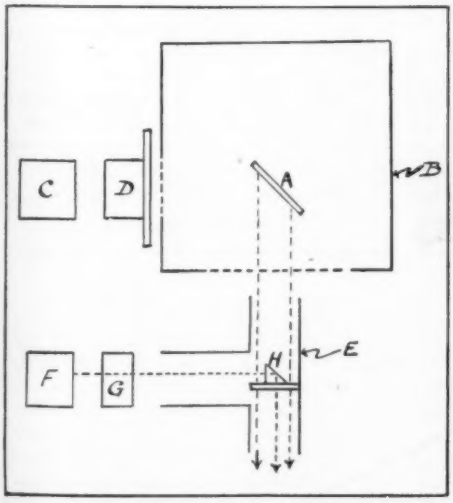
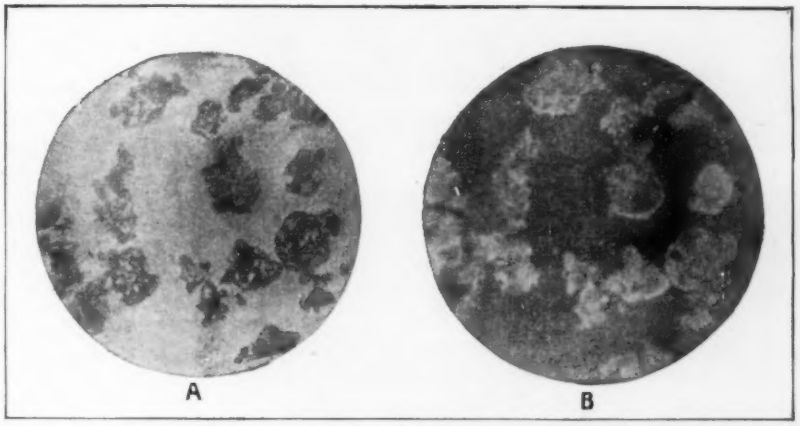


DIAGRAM OF APPARATUS

This apparatus, used to measure the rate of decay of phosphorescence, is described in the accompanying text

If we expose zinc sulfide at these temperatures to white light and then look at it in the dark, it remains dark. But if we now let it warm up still in the dark it will eventually begin to get faintly luminous and will glow with its usual green light so long as the temperature remains elevated. If we were to lower the temperature once more the phosphorescence would apparently cease and reappear again only as the substance warmed up.



MICROPHOTOGRAPHS OF WURTZITE IN ZINC BLENDE

As explained in the text, the appearance A was obtained when the blende was viewed by direct light, and B when the light was shut off. Here the wurtzite phosphoresced while the blende did not

It must be pointed out first, however, that light is not the only cause of phosphorescence, but that X rays, cathode rays and radium will also excite it in phosphorescent bodies. Coolidge, using his new cathode-ray tube, [See SCIENTIFIC AMERICAN, December, 1926,] excited some cadmium tungstate so that it phosphoresced in the dark, the color being slightly greenish. When the substance was cooled in liquid air no phosphorescence was observable even with simultaneous irradiation. On allowing it to warm up, the tungstate glowed first blue, then green, then yellow and later red, passing, that is, through the whole spectrum of colors. Furthermore if at any time during the warming process the tungstate was again thrust into liquid air the phosphorescence at once ceased, and on allowing it to warm up commenced to phosphoresce again only at the temperature and with the color that it had when the second cooling was made.

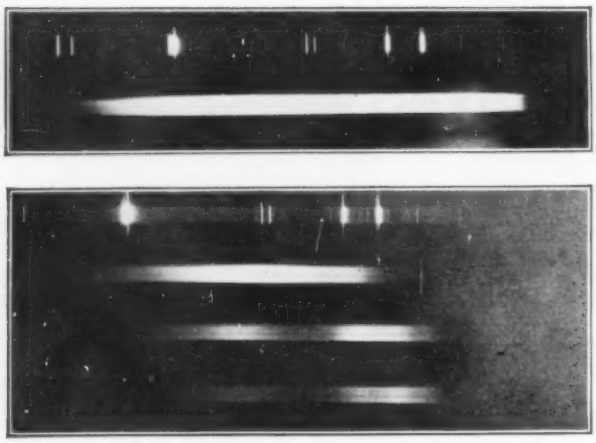
There seems, therefore, to be a definite temperature range within which a certain color is given off.

Such a difference between Coolidge's experiment and the one previously cited for zinc sulfide is due, no doubt, in part to the use of a different agency than light for producing phosphorescence. As mentioned above, beside light and the cathode rays which Coolidge used we may also use X rays or radium as the exciting source. With X rays the phosphorescent effects are precisely the same as with light, except that they are more intense, as would be expected from the consideration that X rays and visible light are but two of the forms which light can take. In the case of the cathode rays, which are a stream of electrons traveling with a high velocity, the energy of the impact of the electron with the phosphorescent material is probably the equivalent of the energy which the material would absorb from light.

All of these methods of excitation of phosphorescence however require frequent exposure of the material if continued phosphorescent light is desired. It is for that reason that radium paints are now in frequent use for all practical purposes. In such paints the phosphorescent material such as the zinc sulfide is mixed with a minute quantity of a radium salt or other radioactive substance. The radioactive decay which this compound undergoes continuously causes effects which are similar to the effects of light, X rays or cathode rays, but being constantly present the phosphorescence is continuously caused; the substance glows constantly and does not appear to decay as in the cases above cited.

FOR practical purposes as a source of light in a dark room therefore the radium paint is a "never-failing" source—that is, until the minute trace of radio active substance has completely disintegrated, a process taking many years. However, the simple phosphorescent material excited for a given length of time by an external agency furnishes more definite results for theoretical purposes.

Some new investigations recently carried out in the physico-chemical laboratories of New York University have revealed to the writer another way in which one can cause the more rapid decay of the phosphorescent



SPECTROGRAMS

Photographs of the spectra emitted by phosphorescing zinc sulfide. The upper spectrum in each case is that of the mercury arc, for comparison. The first band (upper picture) is due to green phosphorescence. The three bands in the lower picture are of green, yellow and orange samples, respectively. The lower two show two bands each, one in blue-green and one in the orange region

light. The method consists in exposing the substance while it phosphoresces to light of a different color.

A simple, diagrammatic sketch of the apparatus employed is shown in one of the accompanying illustrations. A sample of the material is mounted on a plate, A, maintained at constant temperature in the oven B. Radiation from source C activates it after passage through a photometer E, wherein, by means of a small right-angled prism H, light of constant intensity and color from the source F and filter G, can be viewed at the same time for comparison.

As an example of the accelerated decay brought about, the zinc sulfide, containing copper, which normally glows with a greenish light in the dark, can be made to lose its phosphorescence more rapidly than it would lose it in the dark, by exposure to red light. This can be made evident by exposing a layer of the substance to some exciting light, then covering half of the layer and exposing the other half to a red light for a few moments. On viewing the whole layer in the dark it will be seen that the portion exposed to the red light does not glow as brightly as the portion which was covered; it has, in other words, decayed more rapidly.

THAT fact may be coupled with the action of various kinds of light in causing phosphorescence. The color of radiant energy or light is simply a matter of its wavelength, just as the reception from a specific radio-broadcasting station is a matter of wavelength also. Now, a law of phosphorescence found by Stokes states that the wavelength of the phosporescent light is always longer than the wavelength of the exciting light, so that for zinc sulfide, which phosphoresces green, the light to be used as exciting light must be of shorter wavelength than the green light.

Any light of wavelength shorter than the green, provided it is absorbed by the sulfide, will cause it to glow. Any light of wavelength longer than the green will not cause it to glow, but, if the substance is glowing already, will cause that glow to decay more rapidly than it normally would.

To demonstrate that more completely, suppose we take a sample of zinc sulfide which phosphoresces in the green portion of the spectrum and one containing some cadmium sulfide which will phosphoresce with a red light. If we expose both of them to blue light they will both phosphoresce in the dark. If we expose both to yellow light, only the red sample will afterwards glow in the dark, while if the green sample be made to phosphoresce and then exposed to the yellow light it will decay more rapidly. Finally, if both are already glowing and we expose them both to a very deep red light both will decay more rapidly than they would normally.

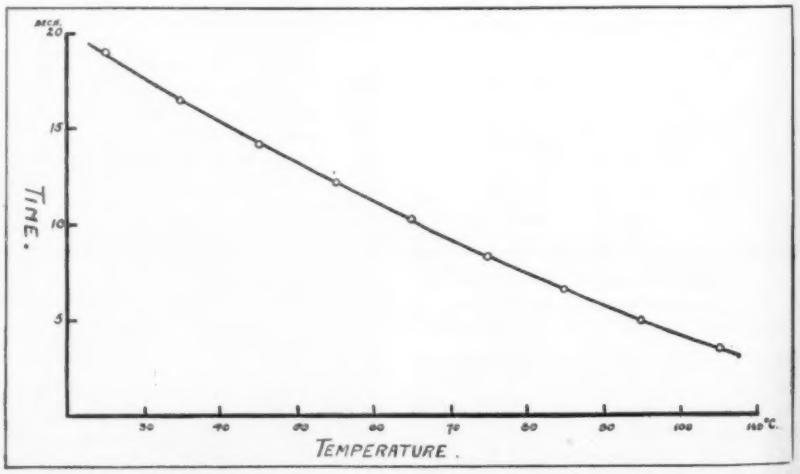
The explanation of these effects which are quite general with regard to the phenomena of phosphorescence, is being urgently sought by both physicists and chemists, in the hope that it may furnish some further insight into the structure of matter—the atomic make-up. How is the energy held by the atom when light is absorbed? Is an electron displaced within the atom, to return later with a re-emission of light as phosphorescence? Why must the "impurity" be present for phosphorescence? Why does only one of the crystalline forms phosphoresce and not the other?

AND while all these questions are worrying the theoretically minded, the practical minds are thinking out new applications of the results found for the use of mankind in general. Already we may read the time in the dark and find our way without stumbling, guided by means of luminous buttons placed at salient points in our homes. Already, too, we are amused at the vaudeville shows and the "Follies" by the weird effects produced by the phosphorescence on the dresses of dancers pirouetting in the dark before an ultra-violet light—a light which, although not visible to our eyes, is capable of causing the phosphorescence since it is of shorter wavelength than the phosphorescent light itself.

What limitless possibilities still exist in the application of simple experimental observations to practical use?

One wonders whether the time is approaching when all our artificial lighting will come through the medium of phosphorescence. The possibility, even at this early stage, of storing in a phosphorescent substance sufficient energy from the sun during the daytime, to furnish light during the night, seems reasonably plausible.

May not such luminescence produced by chemical means be imitated on a large scale and adapted to practical use? Before such is accomplished, however, we must know more about the general properties of phosphorescence, the different ways of producing it, and finally, how to maintain it under useful control.



EFFECT OF TEMPERATURE ON RATE OF DECAY OF PHOSPHORESCENCE

Increase in temperature hastens the decay and therefore decreases the time taken for the phosphorescence to decay to a fixed intensity, that is, it disappears more quickly when heated

On the Trail of the Molecule—II

What Makes Some Chimneys "Draw" Poorly, Boomerangs Soar, Rotor Ships Move and Golf Balls Curve? "Bernoulli's Principle" Explains It

By PROF. S. R. WILLIAMS
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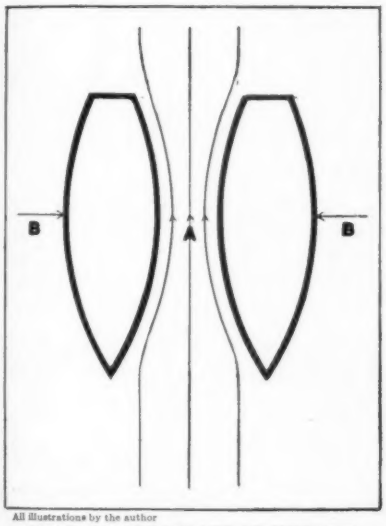
IN last month's installment of this article we saw how two balls were drawn toward one another in a seemingly paradoxical manner when a jet of air or water was directed against their juxtaposed surfaces. Two boats anchored in a stream as near to each other as the width of one of



All illustrations by the author

WHY BOATS DRAW TOGETHER

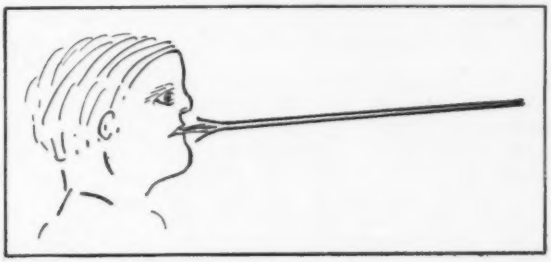
FIGURE 11: *This phenomenon is easily explained by Bernoulli's theorem*

the boats will be drawn toward each other for the same reason.

Figure 11 shows the sweep of the lines of flow of the water past the boats, making the pressure less at A than at B and B. Dynamically it will be the same whether the boats are moored in a stream or are moving forward side by side, for in either case the space between the boats is at reduced pressure. In naval maneuvers it is not an unknown accident for the navigating officers to neglect to take such forces into account, whereupon the boats collide.

Figure 12 illustrates another way in which the forces operative in a fluid stream which flows between two obstacles may be demonstrated. The parallel edges of two sheets of paper are held about three-fourths of an inch apart, and when one blows between them they pull together very tightly.

The author had a personal experience of this kind of force some years ago which may help to explain to others why hot-air furnaces at times do not work satisfactorily. His house stood on the west side of the street about 30 feet from another house. The winds in

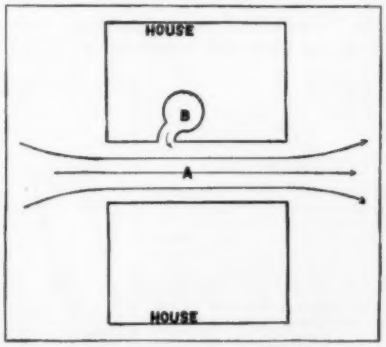


BLOWING PAPERS

FIGURE 12: *An attempt to separate two papers by blowing between them (cigarette papers, for example) often results in drawing them together and stubbornly holding them there —Bernoulli's theorem again*

that region prevailed from the southwest to such an extent that the trees had a slant toward the northeast. These westerly winds swept down between the houses, (Figure 13), as did the water between the boats in Figure 11, and the tendency was for the houses to pull together as did the boats, or like the sheets of paper in Figure 12.

As the houses were well anchored they did not move. But something else did. It happened that the cold-air inlet to the furnace was on the side of the house next to the neighbor's. After strenuous efforts in stoking the furnace during an unusually cold season, it became apparent one morning, on placing the hand over the register, that one could feel the air going *down* the register rather than *up*, as it should. This observation was confirmed by going out to the cold air inlet and noting that a bunch of spar-



A FURNACE "ON STRIKE"

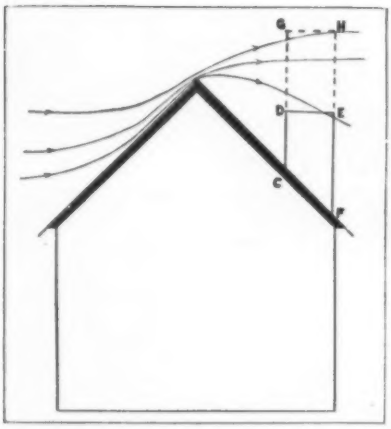
FIGURE 13: *A hot-air furnace "heated backwards." What was to blame?*

rows flew out of it where they had been warming their toes in what had become a "warm air outlet."

The space, A, between the houses, being a region of constriction, the pressure there was less than in the furnace, B, and so the hot air was aspirated out, causing the furnace to work backward. The trouble was remedied by putting the cold air inlet on the west side of the house. Since hydrodynamic pressure is less than hydrostatic pressure, the pressure outside of a house when the wind is blowing is less than that inside, and the result is that our houses have the warm air sucked out of them when the wind blows in the winter, rather than blown out as is the popular conception.

THE draft to a chimney is tremendously influenced by these constrictions to flow of which we have been speaking. If the wind blows directly across the top of a chimney, it acts like an aspirator and the draft is improved. Or better still, if the wind can be given an upward cut past the top of the chimney, one has a forced draft. Any downward slant to a breeze past the top of the chimney militates against a good draft.

A couple of feet added to the height of a house chimney will make a very great difference in the way it draws, and this cannot be ascribed entirely to a greater length of warm air column balanced against the cold outside, which is supposed to make tall chimneys for mills draw well. Figure 14 illustrates the point under discussion. Sometimes the architect has in mind beauty rather than utility and will keep the chimney low, as in CDEF. If the wind is blowing over the comb of the roof, the stream-lines will be somewhat as shown, and those streamlines which strike at a level with DE



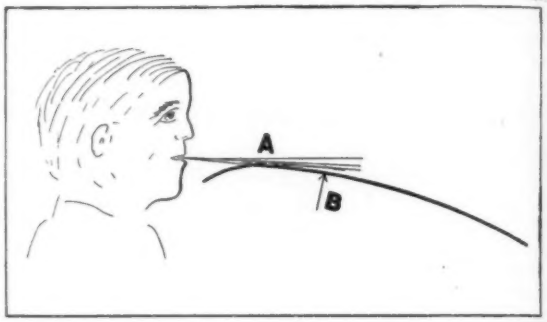
WHY SOME CHIMNEYS SMOKE

FIGURE 14: *Elevating the top to GH often solves the difficulty. Why?*

will be directed downward and the "chimney will not draw for a certain direction of wind." If the chimney is built to the height indicated by the dotted lines DGHE, then the stream-lines will be upward at GH and the chimney will draw satisfactorily no matter what the direction of the wind.

The top of a chimney in a wind is like the vertical tube in an aspirator which has points of constriction about it. Thus the smoke in the chimney, like the liquid in the bottle of an atomizer, is lifted to the top and is blown away.

If a single sheet of paper is held in the hands and allowed to fall down in a curve, as shown in Figure 15, one's first impression would be that blowing across the top of the sheet would blow the outer edge still farther downward. Such is not the case, but it is lifted instead. The shape to which the curvature of the sheet of paper is drawn in Figure 15 resembles that of the camber of the wing of an airplane. If a plane curved as in Figure 15 is forced ahead in stagnant air, the same conditions will exist as for the sheet of paper, and the space above the plane, A, becomes a space of constricted flow and therefore of pressure reduced below that beneath the plane. This unbalanced force provides one of the important factors in the lifting power of the plane. Likewise with the propeller blades on airplanes and boats—to be most efficient they must be constructed along similar lines if they are to give the greatest possible thrust.

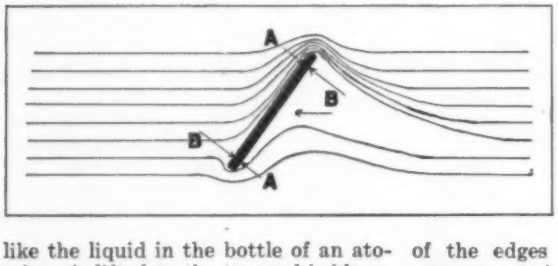


AIRFOIL

FIGURE 15: *Blowing down on a sheet of paper in this manner will actually raise it. The peculiar curve which it assumes is not a mere coincidence with the curve of an airplane's wing—but this is a consideration in itself and so it must be left to the reader*

Those who, in rowing a boat, try to feather their oars on the return stroke know that for the novice one of the provoking tendencies of an oar is to catch at one edge of the blade and instead of skimming the surface smoothly, dip down and go broadside into the water in a most undignified manner. If a large piece of cardboard is allowed to fall for some distance it will have a tendency to fall with its plane in a horizontal position. Bernoulli offers an explanation for these cases also.

In Figure 16 are shown the stream-lines about the blade of an oar as it is swept through the water or as the water flows past it. The sides of the edges marked A are points of constricted flow, in contradistinction to the sides of the edges marked B. Since the pressure at A is less than at B, the tendency for the blade as it moves through the water in the direction of the arrow is to turn at right angles to the direction of motion. Meteoric particles, which are lozenge-shaped, indicate by the fact that one side is fused more than the other that, as they move through the air, they also take on this tendency to move broadside. Doubtless there is some wabbling, as one also observes it in the case of the oar, as was just explained.



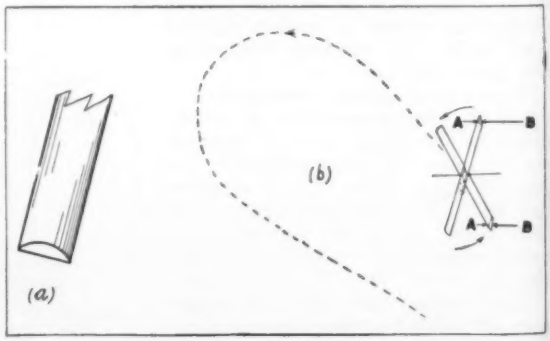
STREAM-LINES

FIGURE 16: *The stream-lines about a plane are symmetrical only when it is "edge-on," or when broadside. The tendency is toward the latter*

Some years ago a friend, forgetting to remove his glasses, dived off into deep water and came up minus his optical addenda. The first impulse was to dive in search of them. A little thought, however, led to the idea that the glasses, when they came off, would continue their journey to the bottom of the lake and move with the surfaces of the lenses broadside to the direction of fall and with the bows trailing in a vertical position, eventually resting on the bottom in that position. If they did this, it ought, in the clear water, to be possible to get the reflection of the afternoon sun from the surfaces of the glasses, and thus locate them. This was done and the glasses were speedily recovered.

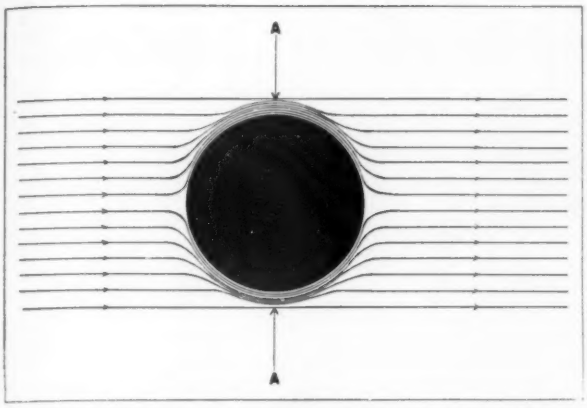
THE flight of a boomerang is a beautiful sight. There are many shapes for boomerangs. The Australians use an L-shaped stick. Others are made in the form of a triangle, a cross or a "T". They may be made with as many cross-arms as one desires. All of them, however, must have the cross-section of the blades a particular shape, similar to that in (*a*), Figure 17, which is really the cross-section of the wing of an airplane.

Suppose a boomerang has the form of a cross as in (*b*), Figure 17. When it is thrown, it is given a rotation about an axis at right angles to the blades of the boomerang. For illustration, let the plane of the boomerang blades be vertical and the top blade moving in the same direction as that of flight. Like a spinning top or gyrostat, it seeks to maintain its axis of spin in a



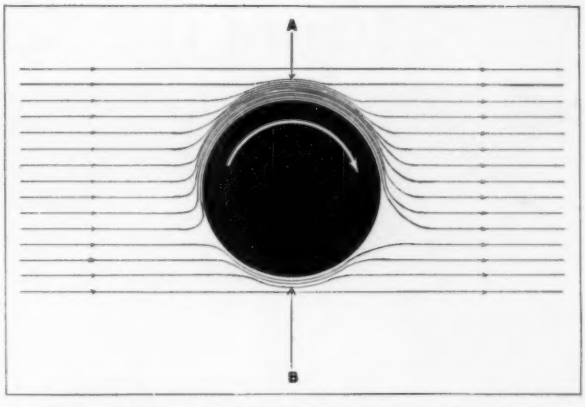
BOOMERANG

FIGURE 17: *The boomerang has a cross-section like that of an airplane's wing. Not all boomerangs are of the return type, while the statement often heard, that a boomerang can be thrown so that it will strike a man behind a tree and return to the thrower, is fabulous*



STREAM LINES AROUND A BALANCED CYLINDER

FIGURE 18: *As the cylinder is moved sidewise through the atmosphere, the stream lines of air around it are symmetrically distributed*



THE ROTOR OF THE FLETTNER ROTOR SHIP

FIGURE 19: *When the cylinder is rotated the stream lines are redistributed. Bernoulli's theorem explains why the ship moves*

fixed direction. As the boomerang spins, the blades will cut the air, so that the top blade cuts the air the fastest of all. Each blade, as it moves through the air, has points of constriction to movement of the molecules of air past the curved side. This causes an unbalanced force to push against the flat side of the blade. The top blade, as mentioned above, will have the largest unbalanced force acting upon it, and so the boomerang in Figure 17 will have its top tipped toward the left of the reader.

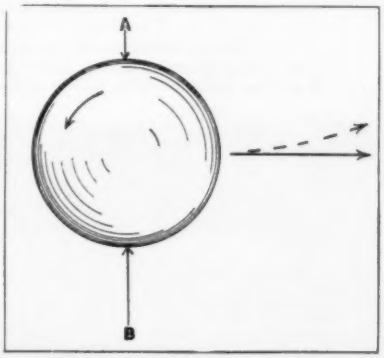
This unequal pressure on the different blades causes the axis of the spinning boomerang to change its direction, and so the boomerang as a whole begins to turn about the axis at right angles both to the axis of spin and to the axis about which the axis of spin is revolving; that is, it precesses and thereby makes possible the throwing of an object in such a manner that it will return to the thrower.

In his book, "Artificial and Natural Flight," page 39, Sir Hiram Maxim calls attention to a propeller with cross-section of blades shaped as in (*a*), Figure 17. "No matter which way it was run," he states, "the thrust was always in the direction of the convex side, which was quite the reverse from what one would naturally suppose." With the principle of Bernoulli in mind, the pulling effect of such a propeller is the only thing to expect.

IN these days a great deal is heard concerning the rotor ship. This type of ship is equipped with large cylindrical masts which rotate. When the wind blows past a non-rotating mast, as in Figure 18, the stream-lines or paths of the molecules will spread uniformly on both sides and lead on past them. On both sides, A and A, there are points of constriction. But being equal, the forces are balanced. If however, the mast rotates, the distribution of the lines of flow are not symmetrical and more molecules will be carried around one side than the other (Figure 19). The side on which this occurs is the equivalent of a constriction to flow and is therefore a side of reduced pressure. The greater pressure on the side of least constriction will urge the mast forward in a direction at right angles to that in which the wind is blowing. Hence, to sail most effectively with the rotor ship, one must have the keel of the boat at right angles to the direction of the wind.

A ball spinning in its flight, whether it be a baseball, golfball or tennisball will have the stream-lines about it as shown in Figure 19 and similar forces will urge it from its straight path. Whether a curve is an "out," an "in" or a "drop" will depend upon what direction is given to the rotation of the ball as it is sent on its flight. Figure 20 gives the direction of rotation and of translation for an "up" curve. As the air is carried around with the rotation of the ball toward A, the equivalent to a constriction is formed, which makes the pressure at A less than at B, with the consequent urge upward of the ball.

Those who have played golf have often observed the ball make a very graceful upward flight as it sailed down the fairway, and then very suddenly break with a drop. A noted English physicist is authority for the statement that if a golf ball is made very rough, and the iron for driving is also roughened so that a very violent rotation may be given to the ball on an undercut, that the point of breaking just mentioned may actually be made into a loop. Some very beautiful curves are often noticed when fouls are struck in baseball. Receiving the impact of the bat with a glancing blow, the ball is given a very lively spin. This is also essential to the curved flight of a pitched baseball.



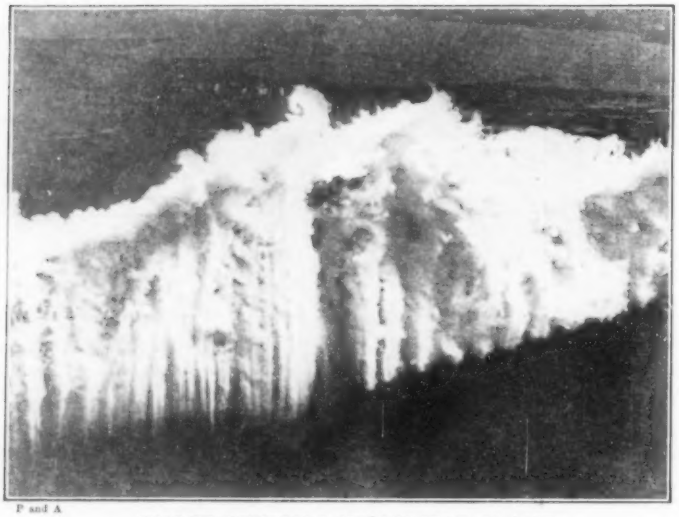
THROWING AN "UP" CURVE

FIGURE 20: *Bernoulli's principle tells why a baseball curves, but the possession of this knowledge will not make one a famous pitcher*

ONE who is not an expert in pitching curved balls may obtain excellent curves by throwing ping-pong balls by means of a small trough fashioned with a handle like a bat. The ball is laid in the trough and then thrown with a rolling motion along the trough. In making sure of the rotation it will aid to dip the ball in thin shellac and roll it in sawdust. When dry this makes a rough surface and by pasting strips of sandpaper in the trough there will be no difficulty in making the ball spin. The relation between the speed of rotation and the speed of translation determines the amount of curvature of the path of the ball. Gall-balls from the oak tree make splendid balls with which to play in throwing curves. They may be thrown either by means of the trough or snapped by one's fingers.

Whether it is a natural instinct or a modern heritage from Greek thought, the fact remains that man is continually seeking to arrange the facts of his universe in a rationally intelligible and unified system. History indicates that when man is most actively engaged in this pursuit, science and civilization make their most rapid advance. When we are able to bring together a great many diverse observations and show that there is a common cause back of them all, we speak of this cause as an underlying principle. Among the various experiments which have just been described it must be obvious that the Principle of Bernoulli is fundamental.

From the Scrap-book of Science—



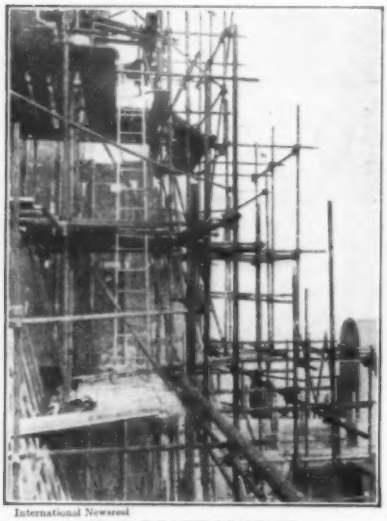
P and A

SMOKE SCREEN LAID BY WAR PLANE

To screen the movement of troops, artillery and other war materiél, airplanes draw smoke curtains around them. The enemy knows something is about to take place behind the screen but he does not know what, nor where to fire through the screen. Chemicals that furnish smoke are dropped from the flying plane

PORTABLE OIL-WELL DERRICK

In Montana they make one derrick serve for drilling two or more wells, drawing it to the new site by means of a tractor. The derrick illustrated above weighs 36 tons and is 82 feet in height



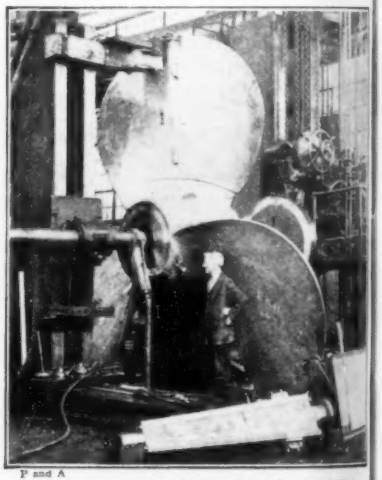
International Newsreel

PIPE SCAFFOLDING

After the wooden scaffolding on a New York skyscraper construction job burned, a scaffolding composed of sections of two-inch pipe was tried. It is said to have made good

TUNNELING MACHINE

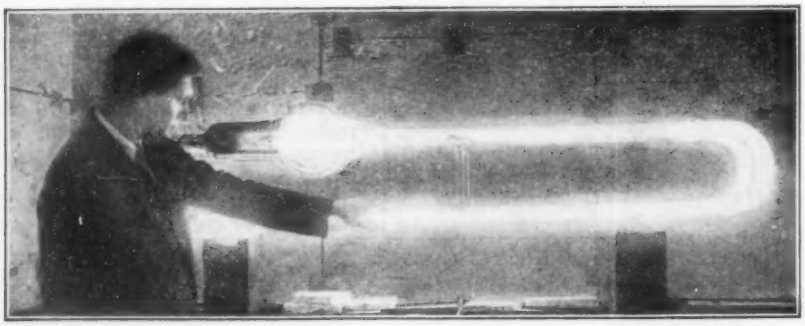
This new machine is equipped with pneumatic tools for tunneling without explosives. There are 18 pneumatic chisels which make a clean cut as the machine slowly advances into the rock that is being drilled



P and A

"LEVIATHAN'S" PROPELLER

A new three-bladed propeller has just been cast for the steamship *Leviathan*. It weighs 64,000 pounds and is made of manganese bronze. Note the comparison with the man



NEW NEON AVIATION BEACON

At Hadley Airport, New Jersey, a new aviation beacon consisting of four high-intensity neon lamps mounted at the top of a 115-foot steel tower has been installed for experimental tests. The light from the neon tubes is mostly red and it was reasoned the long waves of red light should penetrate fogs. Results are reported to be good. At sunset the sun is red because red light penetrates the longer atmospheric path

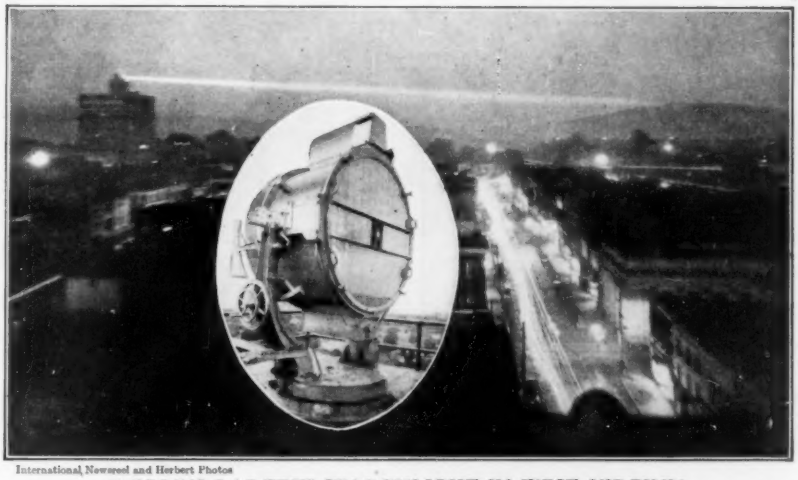
International Newsreel

Camera Shots of Scientific Events

International Newsreel

NEW CABLE AIRWAY

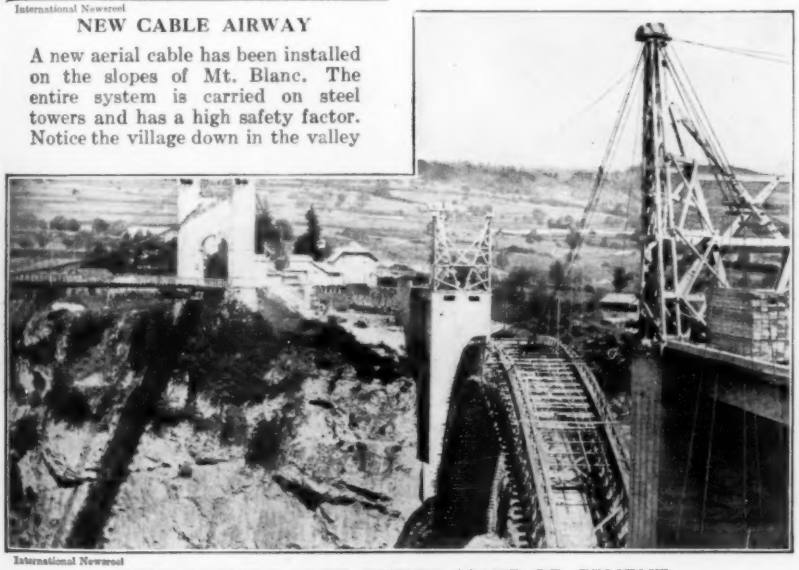
A new aerial cable has been installed on the slopes of Mt. Blanc. The entire system is carried on steel towers and has a high safety factor. Notice the village down in the valley



International Newsreel and Herbert Photos

WORLD'S LARGEST SEARCHLIGHT IN WEST VIRGINIA

At Charlottesville, West Virginia, a searchlight (insert) whose powerful beam is visible over 200 miles in clear weather has been installed for the purpose of illuminating from a distance of three miles the historic residence of Thomas Jefferson—"Monticello." In the picture the beam is shown playing on the residence



International Newsreel

NEW FRENCH ARCH BRIDGE MADE OF CEMENT

Since the World War, French engineers have developed to a high degree the technique of building arch bridges of concrete. The one shown in the illustration above has a span of approximately 800 feet and is 450 feet in height

P and A

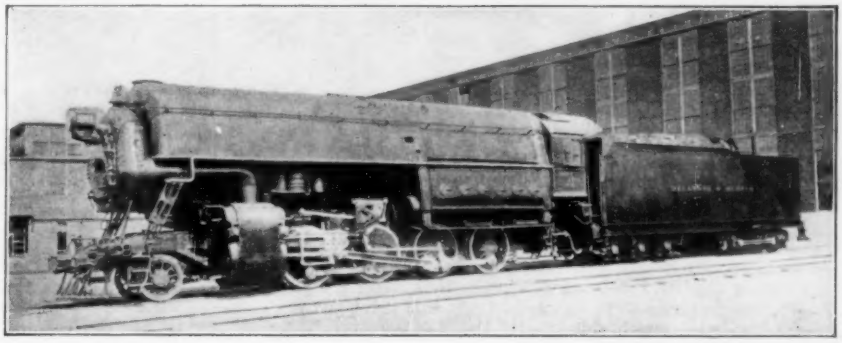
SUBTERRANEAN SUBMARINE!

After long search at Paterson, New Jersey, students of Stevens' Institute of Technology uncovered from the mud the first submarine that was built by John P. Holland

THE "JOHN B. JERVIS"

This is the second of the new combination firetube-watertube boilered locomotives put in use on the Delaware and Hudson Railroad. As the addition of new features gave the locomotive a rather cluttered-up appearance, this one has been sheathed far outside the boiler. The unusual steam pressure used is 400 pounds per square inch. The engine, with the tender, weighs 314 tons

Herbert Photo



Inventions New and Interesting

Examples of Inventors' Work Throughout the World

INSIDE-MEASUREMENT RULE

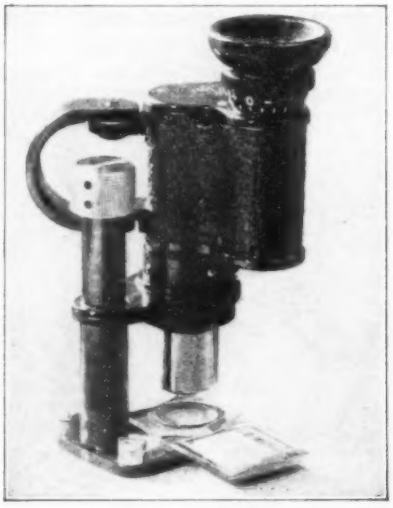
A very handy device for the use of carpenters and others requiring the services of this particular type of tool, is the inside-measurement rule illustrated above and at the left. Inserted in a groove in one end of an otherwise ordinary folding rule is a length of calibrated brass strip. This is marked accurately in inches and small fractions.

SNOW SWEEPER

Using the parts from a baby carriage, an old bicycle, a broken lawn mower, an old brush, and a decrepit two cylinder gasoline engine, an inventor has constructed the above illustrated sweeper.

STUDYING CORAL

From a well-known German firm of optical goods manufacturers comes the illustrated combination telescope and microscope. Above it is shown held in a stand so that the beauties of a piece of coral may be studied carefully. Other uses for it are illustrated on the right.

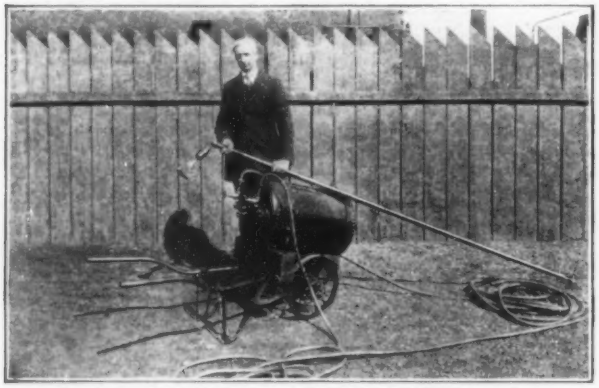


AS A MICROSCOPE

The combination instrument is shown clamped in position for use as a microscope. Accurate adjustments are possible

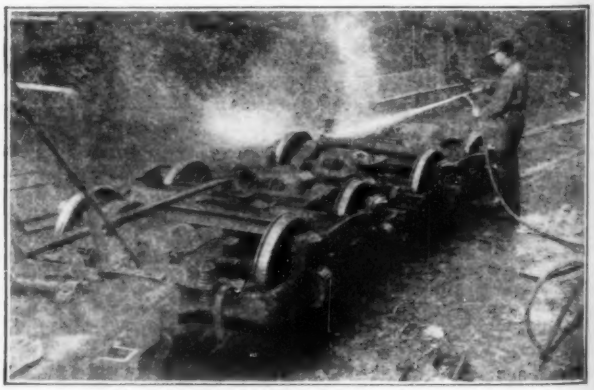
HELD IN THE HAND

Here is illustrated another use for the versatile combination microscope and telescope which is illustrated at left.



WINDOW WASHING MADE EASY

To facilitate the washing of railroad train and factory windows, the above apparatus has been devised. Any cleaning solution can be placed in the tank and fed along the flexible pipe line to the nozzle. At this point is a revolving brush which aids greatly the cleaning operation.



CLEANING CAR TRUCKS QUICKLY

This new high-pressure cleaning system has been installed in the shops of a San Francisco railway company. The method makes use of water at a pressure of 300 pounds per square inch. To speed up the work, the water is heated to 140 degrees and then forced through a flexible hose.

QUICK LOADING OF LUMBER TRUCKS

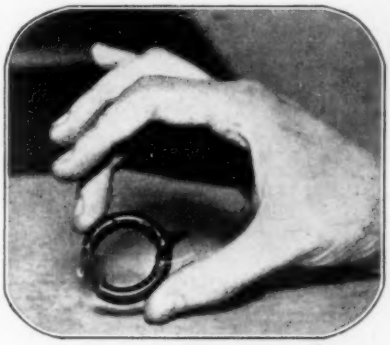
Loading stands which permit lumber to be piled, ready for placement on the truck, are the latest time-saving devices in the lumber industry. In use, the stands are placed and loaded with planks. The truck backs up, the front loader is removed, and the truck is backed further. The load of lumber then slides into place over rollers on the truck

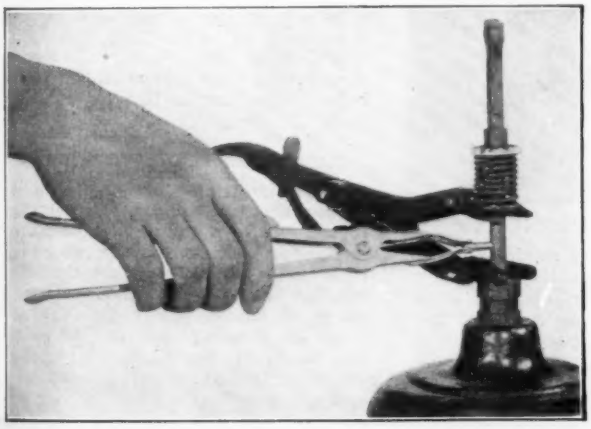
PORTABLE PYROMETER

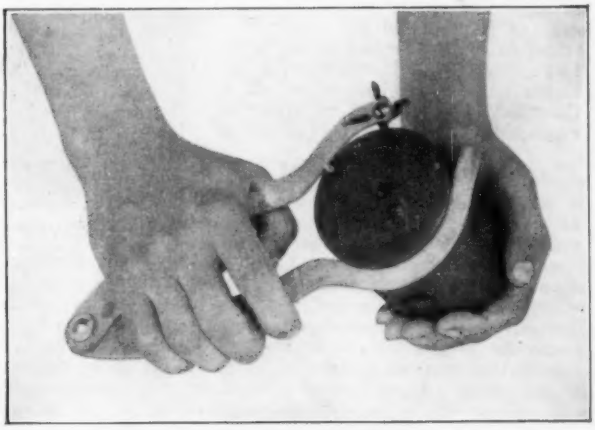
With the small instrument illustrated at the left, it is possible to determine the temperature of a furnace or other fire, while the operator of the device remains at a comfortable distance from the flames

MICROSCOPE LIGHT

The horseshoe shaped object shown at the right is a newly developed electric light for use in illuminating microscope slides. It is said to eliminate casting of shadows which tend to confuse the microscopist







VALVE TOOL

Those who have worked with machinery in which valves must be removed periodically for grinding will appreciate the little tool illustrated above. It is a device for the removal and replacement of valve pins or other valve-locking parts. By its use, the danger of the valve spring injuring the fingers in case of slippage is eliminated. One end of the tool is shaped to accommodate flat or round pin locks, and they can be held at any angle because of grooves provided. The other end, specially shaped for the purpose, holds yoke or horseshoe locks

PISTON RING TOOL

The device illustrated above is for the removing or placing of piston rings. By its use, the ring, of any standard diameter, can be gripped firmly and expanded so that it can be slipped into place on the piston without damage

PISTON CLEANER

When placing new piston rings in an internal combustion engine, it is necessary that all traces of carbon be removed from the ring grooves. If this is not done, the new ring will not seat properly. The tool illustrated above is designed to facilitate the cleaning of the piston-ring grooves, and to do a clean job. There are four cutters for different widths of grooves, and they are instantly interchangeable. It is only necessary to loosen a nut and rotate the cutters to accomplish this change. The tool will handle pistons up to five inches in diameter

Culinary Inventions

Novelties for Preparing and Serving Foods

CONDUCTED BY ALBERT A. HOPKINS

BAKED "HOT DOGS"

A new form of electric baker for turning out a new type of baked product is illustrated above. A frankfurter, sausage, roll of hot meat, or similar delicacy is placed in the center of a roll of dough, the whole is placed in the baker, and four minutes later, a delicious baked sandwich results. It is interesting to note that no grease is employed in the process of cooking.

KEEPING FOOD WARM

Where large numbers of persons are to be fed, the problem of keeping the cooked food warm until the time of consumption is a difficult one to solve. However, by a clever combination of electrical heating units and insulated compartments, one manufacturer has succeeded in producing a device that serves the purpose admirably. One of the portable types is shown below.

IMPROVED DRINKING CUP

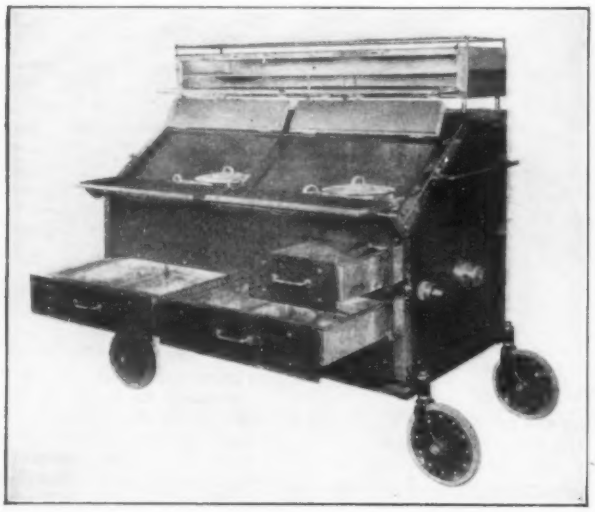
When drinking on a moving train or boat, or when in bed, there is always danger of spilling. This has been overcome by the unique cup illustrated in use above. The peculiar shape of the spout makes it impossible to spill the contents. It originated in France.

DISHES KEPT HOT

Food dishes that keep hot and butter dishes that stay cool are now possible with the new design of utensil illustrated above. The dishes are made with a compartment in the base. If the food is to be kept hot, the compartment is filled with hot water through the filler hole provided. For butter dishes and the like, ice water is used. A screw plug closes the filler hole.

ANOTHER FOOD WARMER

In the illustration directly below is shown another device for keeping cooked food at the proper temperature for consumption. It is similar in construction to the one depicted at the left, but is stationary, while the other one is mounted on small wheels so that it can be moved to any desired spot, thus being particularly suited to hospital use where many patients are to be served.



The Scientific American Digest

A Review of the Newest Developments in Science, Industry and Engineering

CONDUCTED BY ALBERT G. INGALLS

Truck Unloads Itself

TO save the time of trucks which lie idle while warehouse-men are loading them has been a problem over which efficiency experts have puzzled for years, and many schemes have been devised to speed up the loading operation. Austin Denehie, a young Los Angeles inventor, has perfected a device which is said to be the answer to the problem.

Denehie has constructed a frame of steel which is bolted to the chassis frame of a truck, with a jackscrew shaft down the center. The jackscrew shaft is compound threaded and is driven by a standard power take-off which can be engaged by throwing a lever in the cab. As the shaft revolves it carries a demountable body on or off, according to whether the lever is thrown forward or into reverse.

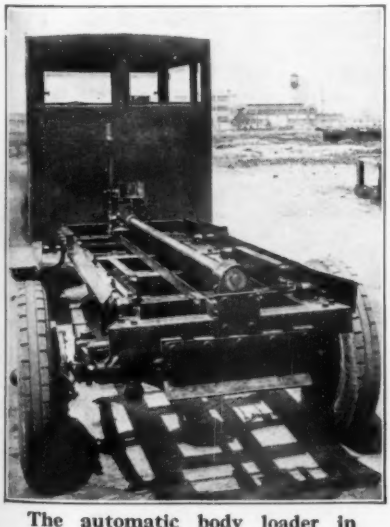
Slung under the demountable body are swivel castors which permit the body to be pushed around the loading platform by hand, or if need be, taken into the warehouse itself.

It takes only eight seconds for the empty body or a loaded one to be moved from truck to dock, or vice versa, while the stopping, coupling and locking devices are all automatic so that when the machinery is put in motion the driver need pay no further attention to it.

Starting the body loader to work. The lever which is being manipulated will be inside the cab in commercial units. It was placed in its present position on the working model so it could be more easily seen in action

Floating Factories

SOMEWHAT tardily, according to Lewis Radcliffe, Deputy Commissioner of Fisheries, writing for *Science Service*, the fisherman is seeking the aid of science—engineering, technology and chemistry. Thus he is developing ways of greatly expanding his sphere of operations. This effort to make available more distant sources of supply is most commendable.



The automatic body loader in detail. The sub-frame is belled out at the back to guide the body into place. The rollers on which the body moves are shown on the right, as is the clamp which holds it in place. The threaded shaft shows in the center of the body

The better insulation of the holds of the fishing vessels and the development of refrigeration machines suitable for installation and operation on board his vessels have greatly increased the distance he may go from his home port. California fishermen are enabled to take much greater toll of the fish supply off the coasts of Lower California; salmon are brought to this country from Kamchatka; the French have built a vessel for operation off the African coast, and other European countries with a diminishing supply in the North Sea and around Iceland are now drawing upon the fishery resources of Greenland. The day is at hand when the fishermen may supply our table with aquatic delicacies from the remote corners of the earth.

Norwegians have perfected whaling ships capable of operating in the Antarctic, thousands of miles from their home port. These ships are fitted with a false bow which can be tilted downward into the water to serve as a runway, up which one of these huge mammals may be drawn to be cut up. Machinery aboard extracts the oil from the blubber and converts the carcass into fish meal. These ships are independent of a land base and having filled their storage tanks with whale oil, which is in special demand by soap-makers, may steam to whatever world port holds forth the best promise of a profitable market for their cargo. In recent years the number of whaling companies has increased rapidly and no ocean area is exempt from whaling operations. In excess of 10,000 whales are killed annually, the maximum yield of oil being reached in 1923, amounting to 44,000,000 gallons. Millions of gallons of whale oil now find a ready market in this country.

This freedom of operations without restraint on the high seas has aroused the fear of intelligent observers that whales may soon become commercially extinct. The only possible control of such operations must be found in international agreement. Such a solution is now being sought by no less an august body than the League of Nations.

A recent development on our own coasts has added emphasis to the dangers resulting from unrestrained operations on the high seas. California authorities have constantly striven to restrict the amount of sardines—so abundant off their coast—which shall be used by the reduction plants for conversion into oil and meal. This has been done so that the great sardine-canning industry may have an ample supply to satisfy the demand for this food delicacy. This "war baby" promises to become a permanent state industry, and is now producing more than a million cases of canned sardines per annum.

A short time ago a Nevada corporation anchored a fully equipped floating reduction plant within the limits of Monterey Bay, but three miles off shore, and proceeded to take sardines for reduction purposes outside the three-mile limit. The State Fish and Game Commission promptly took action and filed suit for a permanent injunction to restrain the company from continuing operations and this has been granted.

The menace still remains and unless some form of international co-operation

A train of Krupp oil containers proceeding by rail. They can be transferred to motor-drawn trailers

How the individual oil containers are transferred from flatcars to trailers for further shipment by highway

is evolved, we may have another "rum row" off our coasts, busily engaged in mopping up the fish supply with utter disregard of the needs for conservation, and bootlegging the manufactured products into whatever port where they can find safe entry.

The most novel development in floating fish factories is that of the *Calgary*, a French vessel of over 2600 tons. This vessel is being provided with powerful refrigeration equipment and three large cold-storage compartments with a capacity of 800 tons of fish. There are six retorts on board. One will be used for cooking lobsters and crayfish; another for making gelatin; two, capable of handling 40 tons of fish and fish waste per 24 hours for conversion into oil and fertilizer; and two others with a capacity of five tons each for the steam extraction of oil from the livers of sharks and rays. There are two oil storage tanks, one of 26,000 gallon capacity for storing fish oil and one of nearly 400 gallons for liver oil. Although it is proposed to operate the vessel off the west coast of Africa, it has been suggested that the vessel may visit Iceland, Greenland, and even North Atlantic fishing banks adjacent to our own coasts.

The power of science in making far distant resources available is well illustrated by these developments. Unless subjected to proper international control, these same developments may encompass the ruination of important aquatic resources and leave us poorer than before.

Submersible Floodlight Projector Used in Recovering Body

USING a new type of floodlight projector after other methods of searching had failed, it was possible recently to recover the body of a man from Province Lake, Effingham, New Hampshire. The man and his wife were drowned when their boat capsized. Despite the efforts of several volunteer searchers working with grappling hooks and dynamite, no trace of the man's body could be found, although the body of the woman was located promptly.

Two days later the submersible floodlight projector developed by the General Electric Company was relamped at Lynn, Massachusetts, to use a 250-watt, 36-volt incandescent lamp instead of the usual 110-volt one. Current was then supplied by three 12-volt storage batteries in series, carried in the boat of the searching party.

The floodlight projector, attached to a long pipe, was lowered to the bottom of the lake and the body was soon located in 15 feet of water, some distance from where the boat had capsized. It was so wedged between rocks that grappling hooks could not dislodge it. The divers who brought the body to the surface reported that, within the beam from the projector, it was easy to see objects on the bottom of the lake.

Novel Oil Transport Used In Germany

THE transport of oil in bulk by railway has always presented difficulties, mainly because the large tank-containers employed are fixed to a car frame or to the tops of the trucks. This usually means that the oil has to be discharged into other and smaller containers before it can be used, with a consequent delay or the installation of large containers which can be used for only a portion of the time. It is, therefore, not surprising that by far the greater part of oil traffic, especially for comparatively short distances, is sent by road in preference to rail, for the former method offers facilities for the transportation direct to the spot where the oil is needed, without the necessity of transferring it into fresh containers.

In Germany, however, where road transport has not developed so greatly as in other countries, most traffic is forced to go by rail. Hardly any new roads have been built in that country during the last thirty years, for during the period from the introduction of railways up to the outbreak of the war the transportation of freight and passengers was almost exclusively handled by the railways. The highways are used only for local transportation.

A firm of oil merchants in Berlin, who do considerable business all over Germany, have therefore adopted a system which permits them to send their traffic by railway as far as possible and to transport it from the rail terminal by motor truck without having to change the container in which the oil was borne by railway. This has been made possible by the use of small tank containers, each of which is mounted on its own wheels. Each con-

Lighted by ordinary storage batteries from motor cars, this special type of water-proof under-water floodlight aids recovery of sunken objects

tainer has a capacity of approximately 1100 gallons and a laden weight of about four tons. Special equipment is required to accommodate these containers, four of which can be carried on each wagon, giving a total capacity of 4400 gallons. Short rails are laid across the floor of the cars and the containers stand and run on these rails. Strong metal hooks and straps hold the containers firmly in position during rail transit.

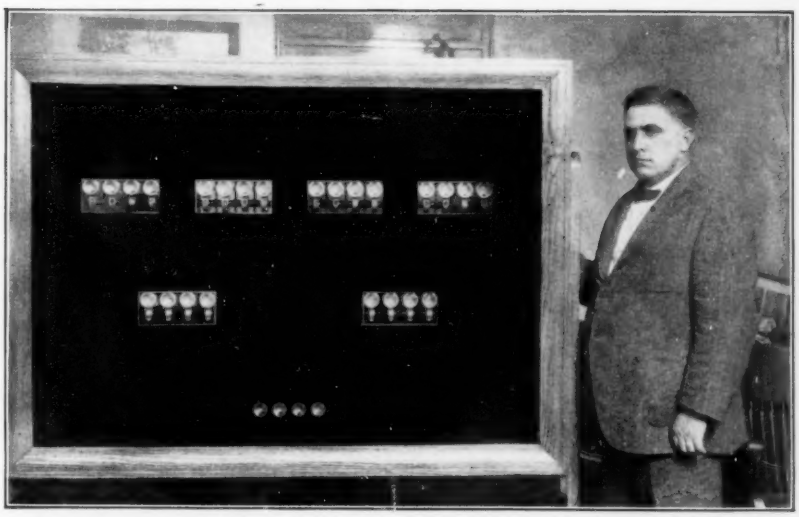
On arrival at destination the cars are spotted on sidings, permitting the road vehicles to back end-on to the rail car. As shown in one of the photographs, the trailer on which the oil containers are transported on the highway has two ordinary wheels at the rear and two smaller wheels at the front. Its body is composed of two rails long enough to hold two containers and strengthened to carry the weight required of them.

Down the center of the trailer runs an endless chain, which is operated by a handle in the rear. A hook at the bottom of each container fits into this chain, which is then moved to haul the containers one by one from the rail car on to the trailer. Stop blocks are fitted to the trailer to prevent the containers from over-running, while the locking of the endless chain insures that the containers are held fast during the period of road haulage. Braces, metal straps and blocks are also used to this end.

During the unloading of the rail car the small front wheels of the trailer are lowered to the ground, thus giving the body a slight downward tilt. This is of considerable assistance to the man operating the endless chain. When the two containers are in position on the trailer the front end is jacked up until the rails on the body are level. These movements are clearly shown in the illustrations.

On arrival at its final destination the front wheels of the trailer are again lowered to the ground, the trailer being disconnected from the tractive unit. In many cases the containers are run directly off the trailers and moved on their own wheels.

This system has a great advantage over the old method of fixed containers, since the railway wagons can be returned for reloading immediately after the containers have been removed and empty containers installed in their place, a matter of a few minutes only, thus saving the time previously occupied in discharging the contents of the large fixed containers. Moreover, by using tractors and trailers on the road the greatest possible use is obtained from the motor tractor units, which can thus be kept at work a large share of the time.



R. R. Graves, of the Bureau of Dairy Industry, with the "herediscope" which he invented to illustrate the transmission of hereditary characteristics

Herediscope is New Contrivance For Demonstrating Working of Inheritance

A MECHANICAL contrivance called a "herediscope" has been invented by R. R. Graves of the Bureau of Dairy Industry, United States Department of Agriculture, to aid in teaching the Mendelian theory of inheritance in dairy animals.

Inheritance, says Mr. Graves, is such a complex study that the average person is unwilling to expend the time and effort necessary to gain an understanding of the subject merely by reading about it. Furthermore, it is extremely difficult even for those well versed in the subject to write or lecture on heredity so that it can be clearly understood by those who have not made some study of the subject. By means of this newly devised machine, tentatively named "herediscope," it is hoped the most simple and fundamental principles of heredity can be more easily explained to livestock breeders, county agriculture agents, extension workers, students of genetics, and others whose work demands that they have some knowledge of the laws of inheritance.

The use of the herediscope need not be confined to teaching inheritance in dairy cattle. Fundamental principles of heredity are the same in plants, animals, and humans.

The machine consists of a number of groups of aluminum cups, each group representing an individual animal and arranged in the form of a pedigree showing three generations—four grandparents, two parents and one offspring. Numerous small, colored balls, each representing a given hereditary character, such as the "factors for high production of butterfat" or "low production of butterfat," are placed at random in the cups of the starting generation. When the operator presses a trigger connected with the mechanism, half of the character-symbols from each parent-cup are transmitted to the offspring, the selection of characters being merely by chance as is the case in actual matings. By repeated matings the observer is able to note how certain characters may be transmitted from generation to generation, or how they may be lost entirely in the process, how they may be present in an individual but covered up by dominant characters, and how in the absence of dominant characters they may again appear.

The machine will illustrate the transmission and recombinations of four separate characters, or it will illustrate the transmission of four multiple factors, in such types of inheritance as milk yield, egg yield, stature or other quantitative characters.

Specific need for a better means of teaching the theory of inheritance was brought to the attention of Mr. Graves when as a result of his inheritance studies on the records made by dairy cattle of the various breed associations, the theory was advanced that the proved prepotent sire that was transmitting uniformly high production was one that was pure in his inheritance for the factors controlling high production, and that if such sires could be used for several generations, a strain of cattle would eventually be bred that would be pure in their inheritance for high production.

It is not enough that a dairy sire be purebred or that his dam be a high producer. He must have an inheritance which is "pure for high production." In other words his germinal makeup must carry only those factors which cause high production; otherwise he would transmit low or average production to some of his daughters. Such sires whose germinal

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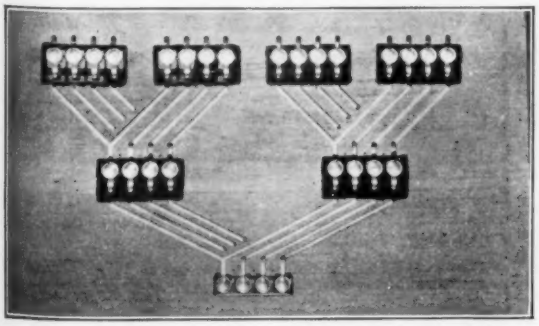
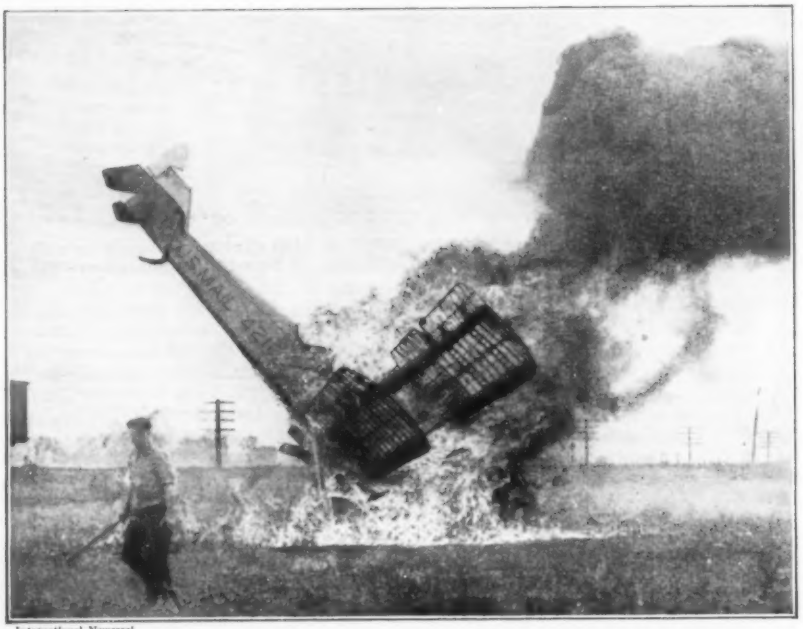


This view of the "herediscope" shows the connecting channels by which the colored balls travel from one cup to the other. The apparently incomplete channels cross those which show here by means of hidden passageways

Learning To Use Our Wings

This Department Will Keep Our Readers Informed of the Latest Facts About Airplanes and Airships

CONDUCTED BY ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York City



International Newsreel

To prevent the use of unsafe planes by "wildcat" pilots, the Post Office Department is burning up many of its disused De Haviland mail planes

Destroying for Safety

THE Air Regulations of the Department of Commerce provide a powerful aid to the safety of commercial flying. But the Department has jurisdiction only over flying between States and a pilot can operate without a license and without an airworthiness certificate for his craft provided he does so within the limits of one state.

The majority of the aerial service operators who conduct schools or carry passengers from a fixed base are experienced, conservative men who realize fully the necessity of every possible safety precaution and employ the soundest possible planes. There remain, however, a number of "wildcat" pilots, willing to purchase and operate disused government planes, no matter what the risk may be to themselves or their passengers.

It is somewhat hard for the public to differentiate between sound air operation and "wildcat" flying. It is therefore very gratifying to see that the Post Office Department, among other government agencies, is not selling its depreciated planes, but actually burning them up to prevent their reaching the hands of the "wildcat." The awe-inspiring photograph of the De Havilland mail plane in process of destruction by fire is one of the best auguries for the safety of commercial flying.

German Transatlantic Liners

THE Germans are taking an intense interest in the possibility of transatlantic airlines. Besides attempts to make the difficult crossing from east to west, powerful German shipping lines are said to be carefully organizing for a commercial service. Dornier and Junkers are also reported on good authority to be building "superplanes" for the same purpose.

Thus, Dornier at Friedrichshafen, on Lake Geneva, is said to be constructing an all-metal flying boat, which is to carry 100 passengers and to weigh 50 tons fully loaded, half of which will be useful load in the form of fuel, oil, passengers, crew and equipment. The power plant is to be of 7000 horsepower, in all probability with a number of engines arranged in tandem fashion along the wing, as is characteristic with Dornier construction. The hull is to be built ship fashion, with ribs, braces and partitions forming water-tight compartments.

Junkers, another famous German constructor, is also planning a 100 passenger ship, of very curious appearance. The plane will consist mainly of a large wing, with the elevators ahead instead of in the conventional tail position. In lieu of the tail rudders, two vertical surfaces will be placed at the tips of the wings, to be pivoted about a vertical axis when steering is required. There are thus radical aerodynamic changes in contemplation, involving a certain hazard. Four engines of 1000 hoursepower each will be employed, housed within the wing but protruding slightly forward of the leading edge.

On top of the wing, at its center, will be a cupola, in which will be stationed the captain, pilots and engineers. A long gangway, in itself a part of the wing structure, will traverse the entire span of the wing, with passenger cabins on either side. In addition to the cabins there is to be a social hall, dining room and baggage room. The entire structure is to be of duralumin, and the wing span is to be 120 feet.

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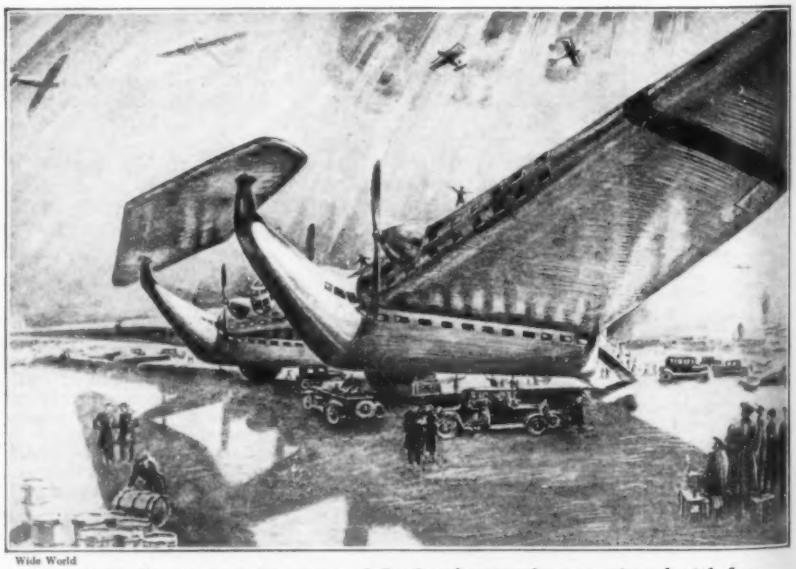
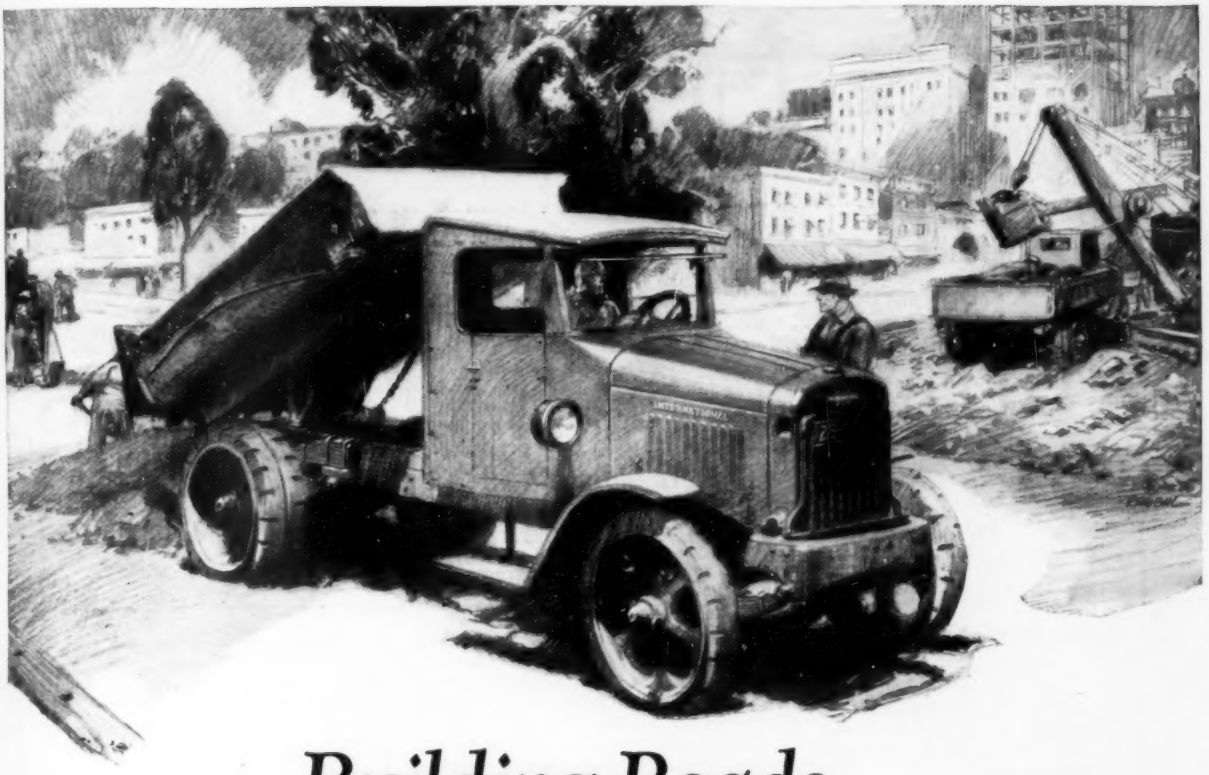


Wide World

An artist's drawing of the proposed Junkers' superplane, equipped with four 1000 horsepower engines and designed to carry 100 passengers



Building Roads and Reputation

The Herringbone Gears in the Double-Reduction Drive Models

Among the advantages in this modern design is the increased efficiency resulting from the greater tooth surface. Other advantages are reduction of wear—evidenced by a remarkable quietness—and unusual accessibility. The performance of the heavy-duty Internationals is due to such developments in International design, the fruit of 23 years' automotive experience.

THOUSANDS of rugged Internationals are working at the mighty job of road making in every state in the Union—and over the world.

The government of Quebec is using a fleet of Internationals to blaze a highway through the virgin wilds of the Gaspé Peninsula. The Peruvian government has 54 Heavy-Duty Internationals on the great Olmus Project in the mountains of Peru.

Internationals are owned by hundreds of cities for street maintenance and public works. At the head of the list is New York City, using fleets of them in eighteen Departments and Boroughs. Another fleet of 40 is helping to build the city's new subways through solid rock, and working under difficulties that try out and prove every truck quality.

International Harvester builds five sturdy models for heavy hauling—two sizes with double-reduction-gear drive for 2½ and 3½-ton loads, and three with chain drive for 2½, 3½ and 5-ton loads. Whatever your hauling problems or your type of load, ample evidence is at hand to show you how well International Trucks will serve you.

Besides Heavy Duty Trucks the International line includes eight types of Speed Trucks, 4 and 6-cylinder, for 1½, 1½, and 2-ton loads; and the sturdy ¾-ton Special Delivery truck. Sold and serviced through 154 Harvester Branches in the United States and Canada, with adequate representation in foreign countries. Folders will be sent on request, and the trucks are on view at the nearest display room.

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INDUSTRIES FROM ATOMS

A Department Devoted to the Advancements Made in Industrial and Experimental Chemistry

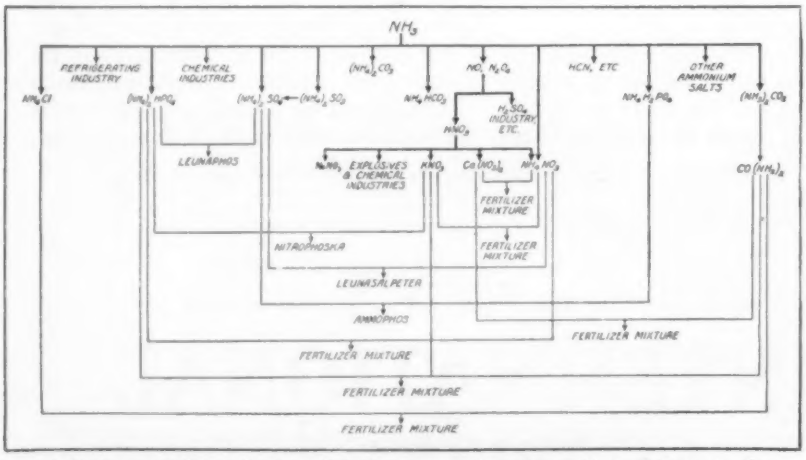
CONDUCTED BY D. H. KILLEFFER

Synthetic Ammonia

RAPIDLY increasing production of synthetic ammonia in the United States has attracted much attention. In a recent article in *Industrial and Engineering Chemistry*, V. N. Morris of the Fixed Nitrogen Research Laboratory, said:

"Less than six years ago the first successful synthetic ammonia plant in America started operation. Since then our progress along the line of nitrogen fixation has been commendable. At the end of 1926 eight plants in the United States were either producing or were ready to produce synthetic ammonia. Notwithstanding the possibility of supply surpassing demand, expansion and construction are continuing without sign of abatement. The Allied Chemical and Dye Corporation, for instance, has recently announced plans for a large plant to be erected at Hopewell, Virgina. It is understood that the output of this plant will go into fertilizers. It is also believed that a considerable expansion of the Lazote plant at Belle, West Virginia, is soon to be undertaken. It is known that part of the output of this plant will eventually be marketed in the form of fertilizers. The recent investigation of American conditions by German interests has made apparent another possible addition to the list of manufacturers of synthetic ammonia in this country. It is also worthy of mention that the plants of the Commercial Solvents Corporation and of the Great Western Electrochemical Company were scheduled to be completed and to start operation about the first of the present year.

"The accompanying chart gives a picture of the various outlets for ammonia. It shows certain potential ones as well as those actually developed. It should be borne in mind that nearly all the salts shown can, if marketed in a suitable physical condition, be used as fertilizers. The various uses of a given compound are not shown except in cases where omitting them would give the impression that the compound served only as an intermediate for the production of some other substance."



A diagram of the various outlets for ammonia. An outline of the growth of the synthetic ammonia industry is given directly above in these columns

Wanted—Cheaper Carbon Dioxide

OF all industrial raw materials, only three, air, water and carbon dioxide, are available to manufacturers for the cost of collecting them. Air and water are easily had almost anywhere but the cost of recovering carbon dioxide from flue gas or other sources is comparatively high. As new uses have been developing for it, a demand for more economical methods of getting it has arisen. On this subject, H. E. Howe of *Industrial and Engineering Chemistry* says:

"The latest use for carbon dioxide as a refrigerant opens up new opportunities in research. If solid carbon dioxide is to be universally used, a satisfactory system of distribution from carefully located plants must be developed, or the solid must be produced in numerous localities where carbon dioxide is normally available. It looks like an opportunity for power plants, especially where there is off-peak power available. The difficulty lies in the recovery of the carbon dioxide from the flue gases. These gases may contain say 12 percent CO_2 (carbon dioxide) whereas gases prepared for the purpose run approximately 18 percent. There is a real opportunity to devise economical methods of extracting carbon dioxide from the flue gases, utilizing off-peak power for liquefaction for the preparation of the refrigerant. There is also an opportunity to perfect improved methods for the manufacture of this gas as a primary product. It is another case of changed conditions calling for new developments, and proof of the well-known fact that, regardless of accomplishment, there is always much new work waiting to be done."

Ultra-Violet Light and Paint Weathering!

ULTRA-VIOLET light is known to have a serious effect on the lasting qualities of paints and its effect on the vehicles used in paints has recently been studied seriously by George F. A. Stutz of the New Jersey Zinc Company. In reporting his investigation at a recent meeting of the American Chemical Society, Mr. Stutz stated the following conclusions:

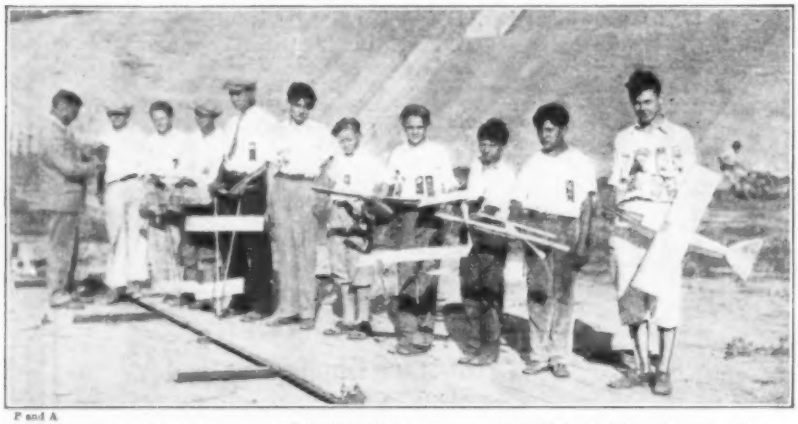
"A raw or untreated linseed oil is quite transparent. A heat-bodied oil is more opaque. A heavy-bodied, air-blown oil is still more opaque. In general, then, in the case of a bodied oil, the ultra-violet light is

(*Continued on page* 459)

Applied Science for the Amateur

A Department Devoted To the Presentation of Useful Ideas. Material of Value To All Will Be Found Here

CONDUCTED BY A. P. PECK



P and A

A group of winners in a model aircraft tournament held in California. Similar contests have been and are being held throughout the country. The columns below and on the following pages give instructions in the art of model aircraft building, and it is hoped that many of our readers will try the sport. Local contests between various types of aircraft models built by amateur aviation enthusiasts can be arranged by interested parties

ANNOUNCEMENT

RECENT developments in the applied science of aviation have brought with them a revived interest in the art of model aircraft building. Knowing that the knowledge gained by the study and construction of such models is of great value when the subject is to be pursued further, the Playground and Recreation Association of America has recently instituted competitions in various cities throughout the country in which homemade model airplanes are to be entered.

In order to desseminate the available information on model construction so that all may try their hand at this interesting and instructive hobby, the above mentioned society has prepared a series of illustrated articles which will appear every month in this department, beginning with this issue and running until further notice. These articles will describe all of the various types of model airplanes, beginning with the simplest glider, and going on to more complicated rubber-band propelled types. There will also be included the design of one model using compressed air for the source of power.

We invite all of our readers to try their skill at this new hobby. We have on hand a list of places where materials for model work can be obtained, and also where further information on the subject may be had. This information will be forwarded to interested parties on request. To further the work and to show our readers what is being done by others, we offer to print, when space allows, photographs and short descriptions of models made, either from our articles or from original designs.

The Editor.

Tools and Materials for Model Aircraft Construction

FEW tools are required in the making of model airplanes. A good sharp penknife is perhaps the most useful tool. This should be very sharp, and one of the blades should be well pointed. For some delicate cutting, a razor blade is preferable to a pen-knife. A ruler is, of course, essential. If possible, the model maker should equip himself with two pairs of pliers, one being of the round nose variety for use in forming hooks and other wire fittings, and the other should have a flat nose and a cutting edge on the side.

A small sharp plane will often come in handy for dressing down wood. A very suitable type of plane is known as the Stanley 75, although suitable planes may be purchased at the ten-cent store. For drilling the holes in propellers a number sixty twist drill is used. This can be rotated either in a hand drill frame or in a small "pin vise" such as may be purchased from a jewelers' supply house. Two other requisites are a candle and a piece of sand paper about number 0 grade. The above tools will enable anyone to make good models. Should the model maker have access to a woodworking shop, the use of a small circular saw and a band saw will make it much easier for him to cut out strips and propeller planks.

Materials for model aircraft construction may be grouped under four heads, namely, wood, metal, fabric and liquid. The woods used are pine, spruce, bamboo and balsa. Pine is, of course, very easy to obtain as it is the common wood used for packing, crating, and house construction. Straight grained, well seasoned pieces should be selected, and these may be either sawed or split to the proper size. Spruce is superior to pine because of its lighter weight and greater strength, but it is seldom used for packing or building and can, therefore, probably be purchased only at lumber yards.

Bamboo is a hard, light wood which is particularly recommended for model building because it possesses unusual strength, can be split to the proper sizes and, when

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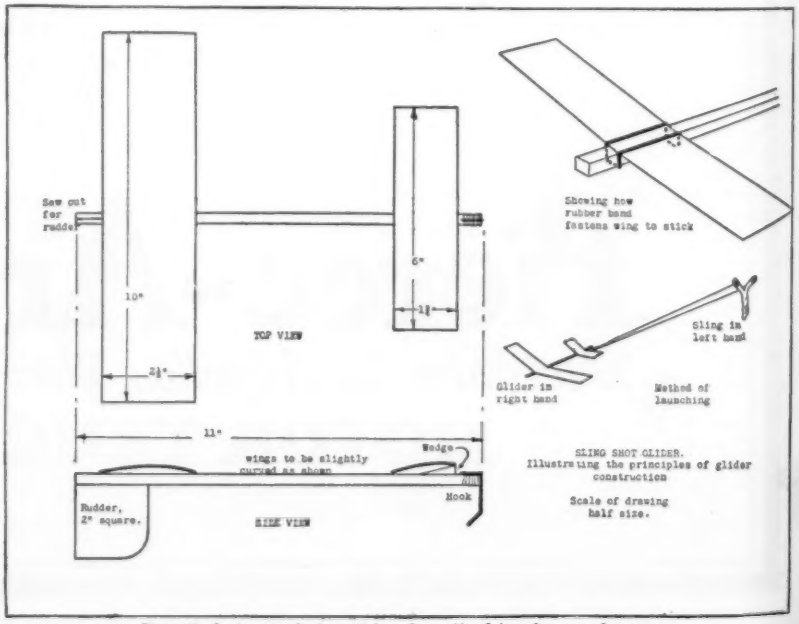

Detailed views of the glider described in these columns

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You are representative of the solid, substantial, staple earning and spending power of America. Some of you are young men—just starting business careers that will, in a very short time, raise your incomes to $5,000 or $10,000 a year or more.

Estimating the incomes of 1,000,000 subscribers of these magazines, at the very minimum, according to statistics furnished by Dr. Daniel Starch of the Harvard School of Business Administration for the American Association of Advertising Agents, they are away over *Four Billion Dollars.* The actual earnings of the readers of these magazines are probably two or three times that sum.

Our purpose is to interest you in this enormous Man Market. For instance, you men buy your own hats—millions of hats; you buy your own shirts and collars, underwear, hosiery, garters, shoes, clothing; you buy your own razors and shaving cream and cigarettes and cigars. You, at least, have something to say about the automobile that goes into the family garage. You buy all the trucks. You buy tires and oil and gas.

Do you, or do you not, have something to say about the kind of roof that goes on your home, bath room fixtures and the furnace?

Without your executive ability, sales skill and earning power, the market in America for all products, whether used by men, women or children, would be reckoned in millions instead of billions; and don't forget that a billion is one thousand million.

The readers of the Man Group magazines *manufacture* nearly all of the merchandise that is made in this country. They *advertise* and *distribute* and *sell* this merchandise.

They also *buy* a whale of a lot of it.

Will you please write me a frank personal letter telling me what you or your company *make;* and especially what you personally *buy* for the family, for yourself and for your company?

Howard P. Ruggles

Ruggles & Brainard *Inc.*

Color Pages

The Graybar Building
New York City

Strays From the Ether

A Monthly Review of the Progress Made In All Branches of Radio Communication

CONDUCTED BY ORRIN E. DUNLAP, Jr.

WEAF Modernized

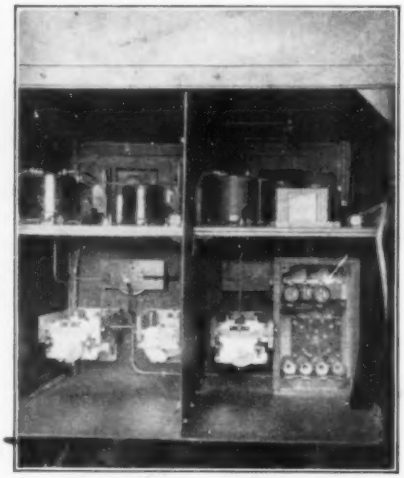
STATION WEAF's new transmitter at Bellmore, Long Island, representing the latest in broadcasting apparatus and an investment of approximately a half million dollars, is now on the air. The power output is rated at 50 kilowatts, which, according to Dr. Alfred N. Goldsmith, Chief Broadcast Engineer, can be depended upon to give reliable service within a radius of 100 miles under all conditions.

The 250-foot aerial is held aloft by two lattice steel towers each 300 feet in height. A vertical lead-in is taken off the center of the aerial proper, thus forming a "T." The towers will be illuminated by flood lights at night to serve as a beacon for aviators and to serve as a warning lest the planes run into the masts or wires over the flat Long Island countryside.

The equipment is located in a one-story stucco building midway between the towers. The power furnished by the Long Island Lighting Company is fed into the installation at 250 kilowatts, according to the engineers. It is said to be sufficient to light 10,000 homes. The electricity employed to light the filaments of the big transmitting tubes would supply enough current to operate the filaments of 200,000 UX-199 receiving tubes, or approximately 50,000 of the average dry battery receivers now in use. The energy utilized to supply the plate curcuit of the transmitter would provide sufficient "B" voltage for 550,000 UX-199 receiving tubes.

An Electrical Set

A NEW radio circuit incorporated in two different cabinet styles and 100 percent electrically operated, was introduced recently in New York by the Kellogg Switchboard and Supply Company. Improved alternating current tubes are utilized so that the set is operated in connection with the light socket, thereby dispensing with all batteries. There are seven alternating current tubes of the Kellogg heater type. The circuit comprises four stages of tuned radio-frequency amplification, detector and two audio stages. The tubes are the same type throughout except in the last audio socket in which a new alternating current power tube is employed to handle volume without distortion.



The white arrow points to the quartz crystals which hold WEAF on its exact wave length. Only one crystal is used at a time, while two others are held in readiness to be switched into the control circuit

The internal part of the instrument is divided into six sections, each of which is housed in a metal box to prevent interaction between the circuits and to aid in making the circuit a sharp tuner. Five of the metal compartments contain the radio frequency tubes with their associated coils, and the detector separately boxed. The sixth box contains the audio amplifier unit.

An individual metal box contains all the power equipment, including a small step-down transformer and "B" eliminator with a 313 type tube. The maximum "B" or plate voltage supplied is 215.

An aerial condenser is provided so that the receiver can be adjusted to work with maximum efficiency with any length antenna. This adjustment is made inside the cabinet, and once effected, the control need not be touched unless the antenna is altered.

There are two tuning controls, one a group switch that regulates the stator windings of the secondary coils, and the other a simultaneous control for the rotors of the coils. A small knob controls the volume, which can be regulated from a whisper to an intensity sufficient to fill a large auditorium with music of high quality.

The set is built in two models, a consolette and in a large Italian Renaissance cabinet with a novel arrangement of the door panels, which can be closed to conceal the radio panel when the set is not in use. An external cone loudspeaker has been designed to work with the consolette, while a built-in loudspeaker of the composition horn type with a 60-inch air column is used with the large receiver. The tubes are mounted on cushion sockets to prevent microphonic noises.

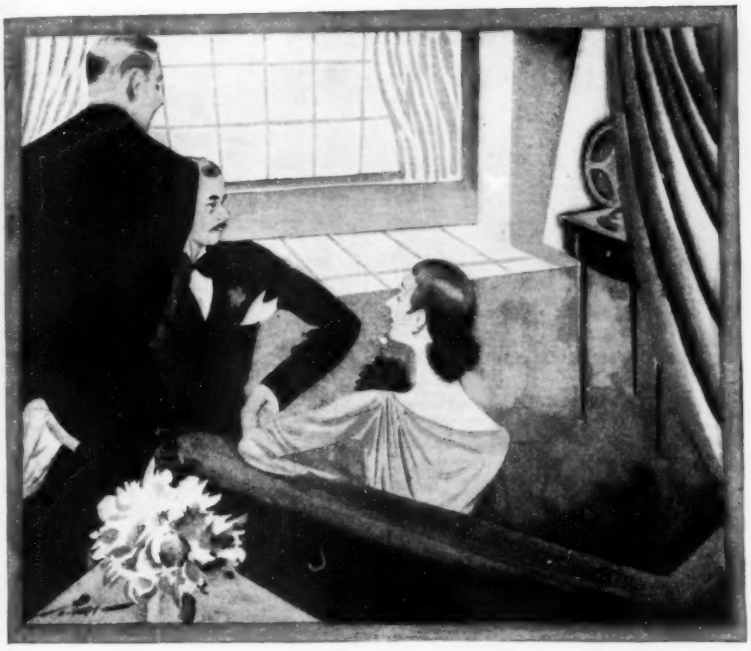
Wells A Pessimist

"I AM inclined to suspect that the life of the ordinary listener is so brief that there may soon be a grave dearth of

At the left is the crystal-control apparatus that holds WEAF to a frequency of 610 kilocycles. At the right are five stages of high-power radio-frequency amplification

Thirty-two high-power tubes used in the new 50-kilowatt installation of WEAF at Bellmore, Long Island. The modulator tubes are located at the far end of the room

... Modern



Here is the Eveready Layerbilt "B" Battery No. 486, Eveready's longest-lasting provider of Battery Power.

Radio is better with *Battery* Power

NOT because they are new in themselves, but because they make possible modern perfection of radio reception, batteries are the modern source of radio power.

Today's radio sets were produced not merely to make something new, but to give you new enjoyment. That they will do. New pleasures await you; more especially if you use Battery Power. Never were receivers so sensitive, loud-speakers so faithful; never has the need been so imperative for pure DC, Direct Current, that batteries provide. You must operate your set with current that is smooth, uniform, steady. Only such current is noiseless, free from disturbing sounds and false tonal effects. And only from batteries can such current be had.

So batteries are needful if you would bring to your home the best that radio has to offer. Choose the Eveready Layerbilt "B" Battery No. 486, modern in construction, developed exclusively by Eveready to bring new life and vigor to an old principle—actually the best and longest-lasting Eveready Battery ever built. It gives you Battery Power for such a long time that you will find the cost and effort of infrequent replacement small indeed beside the modern perfection of reception that Battery Power makes possible.

NATIONAL CARBON CO., INC.
New York UCC San Francisco
Unit of Union Carbide and Carbon Corporation

Tuesday night is Eveready Hour Night —9 P. M., Eastern Standard Time

WEAF—*New York*
WJAR—*Providence*
WEEI—*Boston*
WFI—*Philadelphia*
WGR—*Buffalo*
WCAE—*Pittsburgh*
WSAI—*Cincinnati*
WTAM—*Cleveland*
WWJ—*Detroit*
WGN—*Chicago*
WOC—*Davenport*
WCCO—*Minneapolis, St. Paul*
KSD—*St. Louis*
WDAF—*Kansas City*
WRC—*Washington*
WGY—*Schenectady*
WHAS—*Louisville*
WSB—*Atlanta*
WSM—*Nashville*
WMC—*Memphis*

Pacific Coast Stations— 9 P. M., Pacific Standard Time

KPO—KGO—*San Francisco*
KFOA—KOMO—*Seattle*
KFI—*Los Angeles*
KGW—*Portland*

EVEREADY
Radio Batteries
—they last longer

The air is full of things you shouldn't miss

Dr. J. H. Dellinger, chief of the Radio Laboratory of the United States Bureau of Standards, demonstrating a piezo-electric oscillator or wavemeter

listeners. I suggest that the whole broadcasting industry will begin to dry up. Recent public discussions in the British press about broadcasting are significant symptoms. They reveal widespread discontent among current users of receiving sets. The transmitting authorities, still unwilling to face the plain intimations of destiny, are trying all sorts of novelties nervously and assuredly. My discouraging forecast is mingled with regret," so says H. G. Wells in his prediction that radio will pass away with the "cross-word puzzle and Oxford trousers."

So far no one has been found in America who agrees with the novelist. One prominent radio man suggested that Wells get a new set and a good loudspeaker; another called him by implication an "intellectual snob" and put the British writer in the class of the "intellectually overfed or the spiritually jaded," who laughed at the early automobile, telephone and steam engine.

It is apparent that Wells stands alone on this point, while radio continues to win new followers as the audience moves upward to 7,000,000 and the industry reaches the billion-dollar class.

Industry Expands Into Billion Class

THE radio industry has reached a point in industrial activity where not only its rapid development but its actual size makes it of commanding importance, according to Frank A. Arnold, Director of the Development of the National Broadcasting Company.

Mr. Arnold reports that the radio industry directly and indirectly gives employment to 300,000 people while 3500 manufacturers, distributors and jobbers attend to the making and selling of radio sets and parts.

"In 1920 the annual sales of radio amounted to 2,000,000 dollars," said Mr. Arnold. "During 1926, the sales reached 500,000,000 dollars, while the total sales credited to the industry for the period 1920 to 1926 inclusive are summed up to be 1,493,000,000 dollars—a billion dollar industry developed in six years.

"Out of 27,000,000 homes in the United States, 6,000,000 have radio receivers, leaving 21,000,000 homes to be equipped. Out of 950 broadcasting stations in the entire world, 678 are operated in the United States. Figuring an average of five listeners to a set, there is a potential audience in the United States of 30,000,000 people within the range of a human voice."

Arlington Time Ticks on Four Channels

ARLINGTON'S time signals are now given world-wide distribution by broadcasting them on four wavelengths instead of one as heretofore.

At 11.55 and 9.55 P. M., Eastern Standard Time, the time ticks of the nation's master clock in the Naval Observatory are radiated on 2678, 73.33, 37.25 and 24.8 meters. Each second's tick forms a dot on the radio.

The 29th second of each minute is omitted to make clear the passing of the half-minute. The last five seconds of the first four minutes are also omitted to make noticeable the passing of each minute. The last ten seconds of the fifth minute are not radiated. A dash at noon and 10 P.M. denotes the hour.

Station NSS, Annapolis, sends out the Arlington time signals on 17,130 meters.

Bellows Sounds Warning

COMMISSIONER H. A. BELLOWS points out that two dangers threaten the radio field today. The first is that the public demand for quality and service will progress more rapidly than the ability of the stations to keep pace with it, while the second is that the listeners will become bored and surfeited with the programs they are receiving before the broadcasters are aware of it.

The first of these dangers, he says, can be averted by the electrical manufacturers exploiting the field to a greater degree than they have done in the past by offering more programs. The second danger is harder to deal with as it often happens that the broadcaster has no certain or definite means of checking up the public's reaction to his programs.

The future of radio manufacturing depends largely upon the progress of broadcasting, and this progress in turn depends upon the broadcasters' understanding of the public's demand. Commissioner Bellows suggests that it is a problem that the manufacturers themselves must solve by studying the wants of the public. He points out that this demand is not unreasonable inasmuch as the manufacturers provide so small a percentage of the broadcasting upon which every dollar of their business depends.

British Relay WGY Dance Music

EVERY Tuesday night when air conditions are favorable, Keston, the listening post of the British Broadcasting Company, relays dance music from 2XAF, the short-wave station of WGY, Schenectady.

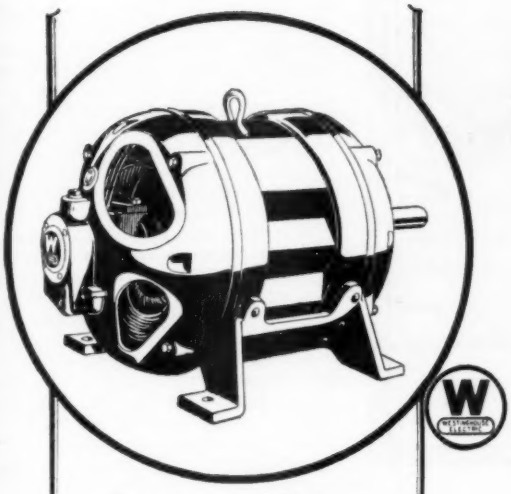
"Sometimes the music, apart from periodic fading, is as good as that from the Savoy Hotel, London, but on occasions the interference from atmospherics is so severe as to spoil the relay and render the remarks of the American announcer unintelligible," reports a British observer. "But these relays have drawn the attention of British listeners to the remarkable ease with which short-wave transmissions from America can be heard direct on one and two-valve sets. Some results can be obtained on most nights in the small hours and occasionally the quality and volume approach those of the local stations except for slight fading."

Balloon Up 31,000 Feet Gets Radio Concert

THE question whether or not radio waves travel far up in the sky has been answered by Captain H. C. Gray, who recently climbed 31,000 feet above Scott Field in a free balloon. He listened in with a broadcast receiver and picked up concerts from KSD and KMOX, St. Louis, hearing them clearly until the altimeter registered 31,000 feet, when he began the six-mile descent.

Captain Gray did not listen during the drop because he was too busy preparing to make a parachute jump. He reported no static at the high altitude, where the temperature was 70 degrees below zero.

The Reisz microphone, developed in Germany, is known as the "variable contact" type. It has no diaphragm, the sounds impinging directly upon a powdered conductor between two fixed electrodes



Latest Addition
to the
Westinghouse
Group of
Squirrel Cage
Motors *for*
Starting Directly
Across the Line

Announcing
The
LINESTART MOTORS

WESTINGHOUSE has seen the need for simpler motor equipment for industrial drives—equipment that retains all the desirable characteristics of the squirrel cage motor and at the same time reduces the initial cost of installation. The result was the LINESTART Motor with the following outstanding features:

Simplicity

These motors can be started directly across the line, which means a simple and economical installation.

Torques

Supplied with either a starting torque which compares with the standard squirrel cage motor, or with a starting torque of two to two and one-quarter times full load torque.

Sealed Sleeve Bearings

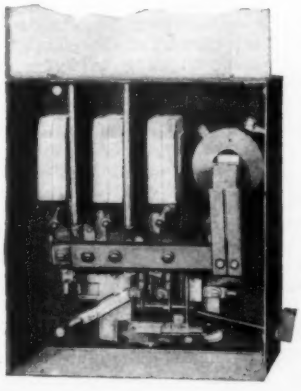
Equipped with Sealed Sleeve bearings, these motors assure consistent performance under all conditions. So effectively has this bearing been sealed that oil cannot escape and reach the windings, nor can dust or grit get into the bearing.

Double Impregnated Windings

The windings are given a double impregnation which not only retains their flexibility, but makes them moisture-resisting and proof against abrasive dust and dirt.

Westinghouse Electric & Manufacturing Company
East Pittsburgh Pennsylvania

Sales Offices in All Principal Cities of the United States and Foreign Countries



The Westinghouse Linestarter

Simple and Dependable

Just push the button and the Linestarter functions, the motor starts and the machine is in operation.

Protects the Motor

When a sustained overload occurs, the thermostatic metal trips the relay, thereby preventing damage to the motor.

Long Life

Even though the motor is started and stopped hundreds of times a day, the magnetic blowout ruptures the arc so quickly that burning and wear of the contacts takes place very slowly.

Easy to Install and Inspect

The starter comes to you complete and with no internal connections to make. It can be mounted in out-of-way places and every part is readily accessible.

Economical Combination

The Linestarter and Linestart Motor provide a simple, efficient and economical combination for industrial drives.

Westinghouse

X94962

The Scientific American Digest

(*Continued from page* 443)

makeup is pure for high production are few and far between, but apparently they do exist. Unfortunately they can not be distinguished from sires whose germinal makeup is mixed, except by noting the production records of a large number of their daughters. When a sire is found to have a large percentage of his daughters in the high-production class, he is considered to be pure in his germinal makeup and is termed a "proved" sire.

Proved sires are being located by examining the records of cow-testing associations, bull associations, and individual herds. Such sires are retained for active service as long as possible. Until the average dairyman gains a better understanding of the laws of inheritance, however, he is not likely to realize the importance of the proved sire. One illustrated lesson with the herediscope should make it possible for him to see why the so-called proved sire is the most certain and speediest means of developing high production in dairy cattle.

As yet there is but one herediscope in existence, the one made by Bureau of Dairy Industry engineers for Mr. Graves. Some of the mechanical features were designed by K. E. Parks and the machine was built by G. F. Betz. It may be possible to simplify the mechanism so that herediscopes can be produced without excessive cost, and small enough in size to permit their use in various places where county agents or extension workers find it necessary to talk on inheritance.

Beryllium, New Light Metal, Promises to Rival Aluminum

AIRSHIP frames and light-weight pistons may soon be made from beryllium or its alloys, and this hitherto little known metal may soon achieve the household familiarity that aluminum has won during the last two or three decades.

Beryllium is a metal about a third lighter than aluminum, but is very much harder, scratching glass easily, like hard steel. According to H. S. Cooper, industrial chemist of Cleveland, Ohio, who has been conducting extensive experiments, it is one of the most remarkable of all metals in its elasticity. It is over four times as elastic as aluminum, and 25 percent more elastic than steel. And while aluminum corrodes easily on contact with salt water, beryllium shows very high resistance to this as well as to other metal-destroying liquids and fumes. It is light gray in color, and takes a polish like that of high grade steel.

It is chemically related to aluminum, and easily forms alloys with it. One of these, consisting of 70 percent beryllium and 30 percent aluminum, is one-fifth lighter than aluminum, far more resistant to corrosion, and in tensile strength far exceeds duralumin.

One quality, which Dr. Cooper points out, may render beryllium especially valuable to the automobile industry. It expands under the influence of heat at about the same rate as cast iron. Thus, when used for light pistons inside the iron cylinders of automobile engines, it will present far less engineering difficulty than do the present types of light pistons, which expand at a rate different from that of iron.

Beryllium ores are found abundantly both in this country and abroad. At present they are hauled out of feldspar mines in New England by hundreds of tons, but are dumped away as waste. The commonest type of ore is known as beryl, polished crystals of which are sometimes worn as semi-precious stones.

Although so new industrially that it can not properly be said to have been born yet, scientifically, beryllium is an old story. It has been known to chemists for 130 years; Vauquelin, a Frenchman, first indicated its existence in 1797. But until recently it has remained merely a museum curiosity and a laboratory material, because it is so refractory that the cost of getting it in anything like a pure state has been prohibitive. But now that the cost of manufacture promises to be materially reduced by a new electrolytic process, it is probable that it will appear on the market in quantity within a few years.—*Science Service.*

Old-Fashioned Carbon-Filament Lamps Die Hard

THE National Electric Light Association has made the surprising discovery that 18,500,000 carbon-filament lamps were sold in this country last year, despite the fact, which everybody knows, that the tungsten filament is much over twice as efficient as a light source. Of the 18,500,000 lamps, 500,000 were for legitimate special purposes, such as indicator lamps and for heating, resistances, and so on; 2,000,000 also were purchased because carbon filaments are more rugged than ordinary tungsten filaments. This leaves 16,000,000 lamps, which were purchased on account of initial low cost or for other reasons. Every one of those 16,000,000 lamps is a source of unnecessary waste, an economic loss, because it must operate at low efficiency. In most cases, good coal had to be burned just to make up for the low efficiency of the carbon-filament lamps as a light giver, in comparison with tungsten lamps—a wicked waste of resources.

A new "rough service" tungsten-filament lamp has now been developed. It will withstand much more abuse than the ordinary tungsten lamp, and, it now appears, it also will take more punishment even than the carbon-filament type. To test this point, the new lamps were placed in a guard and socket and attached to the end of a cord. Then they were dropped repeatedly from a table three feet high. The average of a large number of tests showed the following results: 60-watt carbon-filament lamps, 22 falls; 50-watt, rough-service, tungsten-filament lamps, 55 falls.

As an interesting side light, it was discovered that very light guards are best. Heavy guards increase the breakage, instead of decreasing it.

The Cosmic Ray

FREQUENTLY the editor receives requests for information concerning the cosmic ray which Dr. R. A. Millikan described in an article in the March, 1926, issue of the SCIENTIFIC AMERICAN. Has it yet been definitely established how the cosmic radiation originates, and where? The following note by B. P. Gerasimovic

is exstracted from a publication of the Harvard College Observatory.

"Although the cosmic origin of the high-frequency radiation recently observed at great altitudes seems to be definitely established, there is considerable diversity of opinion among experimental physicists as to its nature and general character. Millikan found that within the limits of uncertainty of measurement, cosmic rays traverse space equally in all directions. On the other hand, Kolhörster four years ago detected daily variations in penetrating radiation, and suggested that the Milky Way, and the regions of Andromeda and Hercules at culmination, are responsible for the maxima of rate of ionization registered by his electroscopic camera. Observations made in the summer of 1926 at the top of the Mönchgipfel, 4100 meters above sea level, by Kolhörster and von Salis seem to confirm this opinion, though their observations on the Eigerwand did not show any noticeable daily variation. The observations made by Buttner and Feld on the top of the Zugspitze, 2830 meters above sea level, during the fall of 1926 and the spring of 1927, established a direct dependence of maxima and minima upon sidereal time, and gave daily curves in agreement with those of Kolhörster. The amplitude of the variation was only 8 percent of the whole penetrating radiation."

The whole question is therefore still in a controversial state; a satisfactory solution can only be given by the experimental physicists.

Finds Tooth Brush Pyorrhea Peril

THE old family tooth-brush is again under indictment with none less than Dr. F. D. Donovan, surgeon dentist to the British royal household, leading the attack.

Practically no tooth-brush in current use is free from germs, declared the guardian of the royal molars in a recent report to the medical journal *Lancet*. He has examined bristles from hundreds of them, including his own, under the microscope with disturbing results.

While pyorrhea is not actively caused by the unclean brush in Dr. Donovan's estimation, he nevertheless believes that it is at the root of 90 percent of the cases now prevalent in the civilized world. Keeping brushes immersed in a one-to-twenty solution of carbolic acid when not in use is the only practical method he has found of keeping them sterile. This is hard on the brushes and fine for the manufacturers, he admits, but is the only remedy he can see at the present time to check the prevalence of the infection.—*Science Service.*

How Athletics are Conducted in Great Britain

"GAMES and Sports in British Schools and Universities" is the title of Bulletin 18 of the Carnegie Foundation for the Advancement of Teaching. The author, Dr. Howard J. Savage, staff member of the Foundation, spent several months in Great Britain gathering materials for this first American descriptive study of athletics in British educational institutions. The Bulletin describes sport in its relation to education at English public and day schools, Oxford and Cambridge, the newer English universities, like London, Liverpool,

Leeds, and Birmingham, and the universities of Scotland and Ireland.

It also discusses British athletic tradition and presents probably the first historical summary of the status of the amateur in England. There are a few comparisons with conditions in America, but since the Foundation is at present engaged upon a study of American school, college, and university athletics, most of these comparative considerations are deferred.

Some of the conclusions of the study may be summarized as follows: Athletics in British schools and universities are valued partly for their physical effects but more for their socializing influences. Although they are not formally recognized by any university, they are aided by Oxford and Cambridge colleges and by many of the newer universities. Most schools insist in one way or another, upon participation in games, but no university compels any undergraduate to take part. "At all universities, sport is essentially casual." Athletics are subordinate to studies, but the lessons learned on the playing fields are carried over into all phases of school and university life, inside the classroom and out.

While personal athletic prowess is highly esteemed, the reputation that victories can bring to institutions counts for comparatively little. Participation being play in the strict sense of the term, the line between the amateur and the professional has come to be strictly drawn in most branches of athletics, nominally drawn in all. Very few persons are dependent upon school, college, or university sport for their livelihood, and no such person, whether coach or trainer, depends upon victory for his living.

Copies of this Bulletin and of the Twentieth Annual Report of the Foundation, which on pages 132-136 deals with American college athletics, may be had without charge on application to the Carnegie Foundation, 522 Fifth Avenue, New York City.

Row of Monuments May Reveal Future Earthquakes

EARTHQUAKE prediction, commonly regarded as an innocent form of humor, promises shortly to find a solid scientific basis, according to the plans of Dr. John P. Buwalda, head of the new department of geology of the California Institute of Technology. The Institute, in cooperation with the Carnegie Institution of Washington, is embarking on an extensive program of laboratory and field research on earthquakes. The plan, which involves large financial outlay, will cover southern California. While there has never been extensive damage from earthquakes in this end of the state, it is hoped that definite scientific data may be secured in order to determine whether or not a major quake is in the making, and if so, where.

Dr. Buwalda tentatively rejects the old idea that a great rock mass may rest silently and immovably under great pressure until some fateful hour when it suddenly cracks and precipitates a disastrous quake. Instead, he takes the position that any really dangerous line of rock slippage would already show a

crack or "fault" line, in which the two abutting rock masses, temporarily stuck together, would gradually be deformed under a shearing pressure during the period of years prior to a serious earthquake. The situation might be likened to an attempt to slide one piece of stiff taffy past another—as long as the two cohesive masses stuck together, a slight distortion or semi-liquid flow would occur along the crack between them while the sliding pressure was gradually being applied.

Dr. Buwalda plans to set a number of monuments in a very precise straight line directly across a suspected earthquake fault. Provided the original survey is highly accurate, the geologist may determine within five or ten years whether the row of monuments has been twisted out of line. The distortion would have to show an S-pattern, and not a direct break from line, if the geologist is to regard the situation as dangerous. If no actual curves are observed, no great earthquake is in prospect; if there is distortion, then it is time for the city council to revise the building code and begin to brace old buildings. The actual disaster would be analogous to the sudden release of a distorted spring and that of its potential energy.

Other apparatus is being designed to record upward tilt of rock as well as the side thrust. Improved seismographic records will be kept not only at the central laboratories at Pasadena but at widely scattered stations all over southern California. Eventually telegraphic communication is to be effected between these stations so as to afford trustworthy information on earthquake velocity.

This research program is of considerable interest to insurance companies now being solicited for large amounts of earthquake protection. Under present conditions such companies are totally at a loss to estimate hazards, and a single disaster could easily wipe out a hundred years of ordinary premiums or bankrupt the concerns.—*Science Service.*

California Redwoods Thrive in Washington

REDWOOD trees, imported from California and planted in the Grays Harbor district of western Washington 14 years ago by one of the large logging concerns of the Pacific northwest, have proved a pronounced success, according to company officials. As a result, plans are under way to transform large areas of cut-over lands in the Grays Harbor section into redwood forests.

In the 14 years, a redwood tree has attained a diameter of 18 inches, showing more rapid growth than that of any other variety of tree planted at the same time. The tree also shows every indication of being high-grade lumber stock. Other varieties planted included spruce, fir, pine, and red and white oak. Encouraged by these results, the company is undertaking the growing of the redwood trees from seed, and in addition has planted more than 1000 acres with spruce, fir and pine seed. Success in these seeding operations will lead to reforestation on a large scale, lumber officials say.—*Science Service.*

Industries From Atoms

(*Continued from page* 446)

absorbed almost entirely at the surface. A raw linseed oil, however, allows the light to penetrate a considerable distance before it is completely absorbed.

"On exposure to the mercury arc, or to sunlight, a film of raw linseed oil becomes more transparent (bleaches). A film of air-blown oil also bleaches, although not so much as the raw oil film. A heat-bodied oil film, however, shows but little change and may even become more opaque on exposure to the ultra-violet light. This leads to the conclusion that, in the case of a raw oil, a material is produced on drying and aging, which is acted on by ultra-violet light in such a way as to convert it into some other material more transparent to ultra-violet light. In the case of a heat-treated oil, an opaque material is produced on drying and aging, which is not changed to a more transparent form when acted on by ultra-violet. Instead the ultra-violet light may accelerate the formation of the opaque material. An air-blown oil would seem to contain some of each of these materials since it is rendered somewhat more transparent by exposure to the ultra-violet light.

"Perilla oil becomes more transparent on exposure to the ultra-violet light. China-wood oil also becomes slightly more transparent. Poppy and soy-bean oils becomes more opaque in the near ultra-violet and more transparent in the far ultra-violet.

"All the varnishes measured are quite opaque. Moreover, on exposure to ultra-violet light they become more opaque (yellow). The tendency to yellow is least in the case of a long oil varnish high in linseed oil and is greatest in the case of a short oil varnish high in China-wood oil. Apparently the gums present are largely responsible for the yellowing of the varnish as well as its high initial opacity.

"The results for lacquers show that clear nitrocotton is quite transparent. The addition of a plasticizer renders it more opaque at the shorter wave lengths. This is true of all the plasticizers commonly used. The further addition of gum renders the lacquer still more opaque. Also, ester-gum is much more opaque than dammar. Exposure of the lacquer film to ultra-violet light or sunlight results in the formation of a deep yellow color and a corresponding tremendous increase in opacity to ultra-violet light.

"Practically all vehicles have high absorption at the shorter wave lengths, below the limit of the sun's spectrum. Therefore, whenever a vehicle film is exposed to a source of short ultra-violet radiations (2800 Angstrom units or less) the energy is practically all absorbed at the surface. This accelerates decomposition, hardening, and similar reactions at the surface only, the underlying film not being affected.

"On the contrary, when exposed to sunlight, the radiations, being above 2900 Angstrom units, are sometimes able to penetrate a considerable distance into the film before being completely absorbed. This difference should be considered in interpreting accelerated weathering results where the light source used is one rich in the short wavelengths beyond the limit of the sun's spectrum."

Vitamin E in Cod-liver Oil

VITAMINS, essential factors in our food, have received much attention in recent years. The only methods of detect-

ing their presence has been by feeding experiments with animals. A recent investigation in the laboratory of Iowa State College by Nelson, Jones, Adams and Anderegg had to do with the detection in cod-liver oil of the vitamin necessary to reproduction. In reporting their finding to the American Chemical Society, these investigators state:

"Considerable interest has been manifested during the past few years concerning the existence of a substance designated as vitamin E. Supposedly this unknown dietary factor is required for normal reproduction, and in its absence animals become sterile, although they may grow to full adult size at the normal rate."

After extensive experimental feedings under various conditions, the following conclusions are reached:

"Reproduction results obtained with cod-liver oil depend upon the manner in which the oil is administered.

"Reproduction is much better on synthetic diets containing cod-liver oil than on synthetic diets with filtered butter fat. If the animals on the synthetic diet containing butter fat have a low hemoglobin content (and such may be the case) whereas those on cod-liver oil have a normal erythrocyte count and hemoglobin content, then there is present in cod-liver oil a specific vitamin which is required for normal iron metabolism. This conclusion is based on the supposition that the results of Hart, Steenbock, Elvehjem, and Waddell are correct—namely, that their animals suffering from anemia received a sufficient quantity of vitamins A, B, and C; and that ultra-violet light did not remedy the condition. This problem is now under investigation in this laboratory and results will be published when they are complete."

Re-Refining Dry Cleaners' Naphtha

DRY cleaning in the United States consumes about thirty million gallons of naphtha per year and the cost of this is one of its largest items of expense. A process for recovering used naphtha for re-use has recently been developed which will reduce this item of cost considerably. In describing the new method before the American Chemical Society, its inventors, Flowers, McBerty and Dietrich, of the De Laval Separator Company, said:

"The method consists of treating part of the solvent used continuously to remove

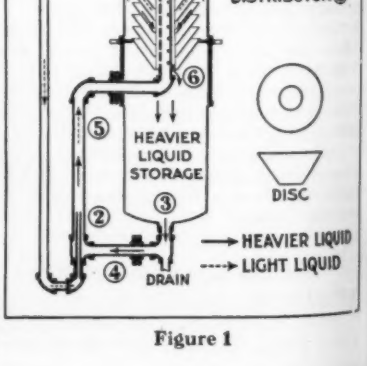


Figure 1

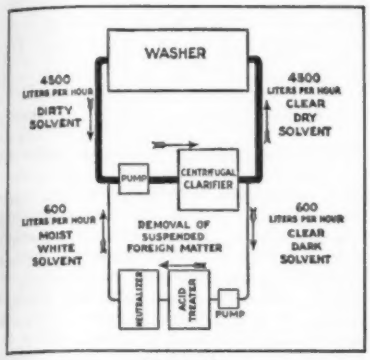


Figure 2

water and suspended dirt followed by treatment with sulfuric acid and alkali to remove color. A new type of self-contained apparatus had been developed for carrying on reactions between a continuous stream of one liquid and a second liquid or a solid. (Patents on this apparatus are pending.) The essentials of this equipment as constructed for bringing about the reaction between a 20-liter charge of concentrated sulfuric acid and a 600-liter per hour stream of used cleaners' solvent are shown in the schematic cross section, Figure 1. A duplicate of this apparatus, except that high-chromium steel disks are provided to prevent rusting, is used for the second step in the process—neutralization with an alkaline solution containing free ammonia. The tanks required for the 600-liter per hour units now available are 35 centimeters in diameter by 125 centimeters high. The acid-treater and neutralizer together occupy a floor space 1.5 by one meter and require 2.5 meters of head room. In this equipment provision is made for drawing fresh charges of chemicals into the respective tanks by establishing a partial vacuum in them by means of a small vacuum pump.

"The principle of operation of this equipment is as follows: The solvent stream enters at (1) Figure 1, through the mixing nozzle (2). The chemical reagent flows from the storage space (3) through the pipe (4) and mixes with the solvent stream in the pipe (5). The mixture of the two liquids rises into the distributor (6) in much the same manner as the mixture of air and water rises to the surface in the air-lift pumping of deep wells. The distributor (6) sends the mixture into the disk-stack (7), which provides about 2.2 square meters of settling area in which the heavier component is required to fall a maximum of 7 millimeters before it strikes a disk surface, on which it collects and down which it flows to drop finally back into the storage space (3). The solvent stream, now carrying not more than 0.05 percent by volume of acid tar (or about 0.15 percent of neutralizing solution) flows upwards past the periphery of the disks and finally out through (8).

"The refining of used cleaners' solvent by means of sulfuric acid is, of course, only practical for a solvent from which suspended dirt and moisture have already been removed. Furthermore, since the neutralized light-colored solvent may entrain about 0.05 percent of aqueous solution, it cannot be admitted to the washer until this has been removed. To meet these conditions a circulating system, shown schematically in Figure 2, is used.

"The decolorizing operation costs about 0.5 mill per liter, as shown by data from

eight months' experimental plant operation, during which time 5000 kilograms of clothing, blankets, rugs, et cetera, were dry-cleaned."

Non-Toxic Cotton-seed Meal

COTTON-SEED meal has a high nutritive value when used as a stock feed, but unfortunately it contains a material, called gossypol, which has a deleterious effect upon animals to which it is fed. This constituent of cotton-seed meal is decidedly toxic and very difficult to remove. A recent investigation by Willis D. Gallup at the Oklahoma Experiment Station has shown that steaming either the seeds or the meal for a longer period than is customary in oil mills destroys this toxic principle and yields a feed of high value. This discovery opens the way for a much larger use of cotton-seed meal than has heretofore been practicable.

American Possibilities in Growing Rubber

AMERICA'S dependence on foreign sources for necessary raw materials is frequently emphasized. Perhaps the most important of these is rubber. Mr. Samuel Wierman, in commenting on this situation in *Industrial and Engineering Chemistry*, points out that there are many latent possibilities of American independence so far as rubber is concerned in tropical America. He goes on to say:

"One is impressed with the fact that in tropical America are vast areas of land with suitable soil and climatic conditions for the growth of all tropical products required by the United States. Much of this land is north of Panama and but a comparatively short haul from our centers of industrial activity. All these areas are capable of being connected with the existing railroad systems without prohibitive cost.

"The principal objection against development of these areas seems to be the high price and scarcity of labor. But is this such an overwhelming handicap as to jeopardize our supply of essential raw materials in time of national stress? Obviously, one cannot expect to find in any part of the world vast areas of available land and also an abundant population. If the population is there, then the land is occupied by it. In Malaya the labor for the rubber plantations is imported from British India, at least five days' sea journey distant. In Sumatra the labor for the plantations is imported from the thickly populated island of Java. In neither place has much success attended the efforts to colonize a resident labor force.

"Is not this difficulty of labor unduly stressed? Cannot much if not all, of it be overcome by organization and intelligent direction? Today, rice, the food of Oriental coolies, is being shipped from California to the Orient with the cost of a 30-day sea haul added to it.

"For good or ill, the destiny of our neighbors to the south of us is bound up with the United States. Instead of sending millions of dollars across the seas for the development of foreign countries, why not direct this creative force to our American neighbors and help bring to them prosperity by assisting them to develop their wealth of natural resources while at the same time insuring ourselves against any interruption of supplies of raw materials."

Applied Science for the Amateur

(*Continued from page* 448)

heated, can be made to form various shapes. Bamboo comes in poles. These may be obtained either as fish poles or as rug poles. Hardware and sporting stores usually carry the former, and the local carpet merchant would probably have the latter. A discarded porch screen may be found to be made of bamboo. A few lumber yards carry this wood.

Balsa wood is extremely useful in the building of the finer grades of models because it is very light and can be easily worked. Physically speaking, it is lighter than cork and one-half as strong as spruce. It has practically no grain. This wood is not at all common. Should the model maker be near a flying field, he may be able to obtain some from the men there. Balsa wood may also be purchased in pieces 40 inches long, 5 inches wide and 2 inches thick for 75 cents each. It should be emphasized that balsa wood can be properly cut only by the sharpest tools and the strips from the saw should be lightly sanded with sand paper.

Metal is used for several of the model aircraft fittings. Small nails are used for propeller bearings on the light models. These are hammered into shape as will be explained in a near future article. Other fittings are made from small piano wire, which is obtainable at music and hardware stores. Sizes number 10 and 15 are used, and a coil of each will provide many fittings. It is suggested that the executives purchase this wire in coils from which the boys can secure pieces. Because this wire is so hard, it can be cut only by very strong pliers or special piano wire cutters. These special tools could perhaps be borrowed. Should piano wire be unobtainable, domestic wire articles can serve as substitutes. Paper clips and hair pins will do for the smaller fittings, and where stiff wire is needed, as in the propeller shafts, hat pins are useful. Ten-cent stores usually handle these articles. In order to reduce friction between the propellers and their bearings, small washers are used between. These are number 14 washers, procurable at any hardware store. Dress spangles also make excellent washers and are smaller than the ones just mentioned. Spangles are a notion store product. These are very cheap; ten cents will buy enough for a dozen models.

Occasionally fine steel wire about number 32 will come in handy for binding small pieces of wood and fittings together. Hardware stores carry this. In the scale models, fittings for holding struts, etc., are often made out of pieces of metal tubing. This can be procured in the larger hardware stores, and often scraps are obtainable in garages. On scale models and occasionally on scientific models, metal can be soldered together to produce strong joints. This method, because of its weight is, however, seldom employed. If the model maker does not already know how to solder, he will find this ability occasionally useful. If difficulty is experienced, he should be reminded that good soldering depends on having the articles to be joined thoroughly clean and having the soldering coppers well covered with solder before applying them to the metal. A suitable soldering paste should be applied to the articles to be soldered before they are touched by the solder itself.

The use of fabric in model construction

occurs most prominently in the wing covering. Many model makers use China silk for this purpose. Practically all notion stores carry this and it retails at about a dollar a yard. Most models require about a quarter of a yard. For the very light scientific models, thin paper is used for wing covering. This may be either Japanese tissue paper which can be purchased from Oriental shops such as Chinese and Japanese curio establishments, or rice paper may be used. Rice paper is used by draughtsmen for tracing and can be purchased from draughting supply houses.

The price for a sheet about a yard square is 15 cents. One sheet will cover about three models. Another fabric employed for covering wings is gold-beater skin. This is an animal product obtained from the lining of a cow's stomach and is very thin and light.

The usual source of power in model airplanes is rubber. This is used in unbroken lengths which have a cross section of about one-eighth by one sixty-fourth inch. This rubber thread costs about a cent a foot. Should some model makers prefer to use a substitute, rubber bands can be linked together like a chain to produce the desired amount of rubber. Silk thread, size A, is used for binding the parts of models together. All notion stores carry this. To prevent the hooks from cutting the rubber thread motors, many model makers use a small piece of rubber tubing over the hook. The variety used is known as spectacle tubing and is handled by opticians and rubber supply houses. An excellent substitute is obtained by using the rubber covering of small telephone wire. This may be pulled off of the electric wire and similarly placed over the model hook. A half inch length is sufficient for each hook.

Liquids in model construction are used in two forms, namely, as adhesives and as wing coating preparations. The most suitable adhesive for model construction is a cement known as "ambroid." This has the advantage of being water proof, quick drying, and extremely tenacious. It may be purchased from hardware stores and from stores which sell supplies for boats. Commercial airplane "dope" and banana oil, which latter is sold by drug stores, are used for fastening the fabric to the wing frames. The "dope" is obtainable from commercial airplane supply houses.

Wing covering preparation is used particularly on silk covered wings to strengthen the fabric, make it air tight, to reduce surface friction, and to tighten it upon the frame. Colodion obtainable from the drug stores, can be substituted. A solution of strips of celluloid dissolved in banana oil makes a good wing preparation. Airplane "dope," which is used on the large machines, can be used also on models, but it should be diluted for model use. The solvent for airplane "dope" is the chemical acetone which all drug stores sell at about thirty cents a pint.

The above mentioned materials can be used to produce all airplane parts, but occasionally pieces of toys and other mechanisms are found that will lend themselves to model airplane construction. For instance, wheels for scale model airplanes can be obtained on ten-cent store toy wagons. Little ten-cent store celluloid canoes have been used successfully as floats for hydroplane models. Imitation radiators for the front of scale models can be built

(*Continued on page 472*)

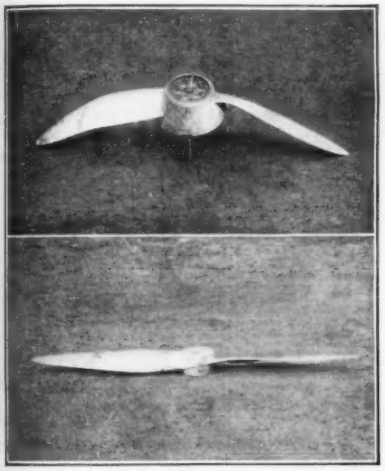
Learning To Use Our Wings

(*Continued from page* 444)

These ships constitute somewhat of a jump from accepted practice and must be considered as highly experimental.

Before and After

THE Reed one-piece duralumin propellers have participated in the securing of many airplane records and trophies. For example, the successful Schneider Cup Racers for 1923, 1925 and 1926 were all equipped with this type of propeller. It, of course, was used again in this season's Schneider Cup Race held in Venice. The metal propeller suitably designed can employ with safety an airfoil section much thinner and more efficient than that possible in a wooden propeller. Moreover, in



Top: **Fairey-Reed duralumin propeller after crash.** ***Bottom:*** **The same propeller in perfect shape after it has undergone repair**

case of a crash or a bad landing in which the plane noses over, the duralumin propeller can almost always be salvaged. The "before and after" photographs appended are illuminating. Here we have a Fairey-Reed propeller, bent out of working shape by a crash, assuming after repair (by simple mechanical manipulation), a perfectly mechanical and workmanlike appearance.

Noise

AT a conference of the National Advisory Committee on Aeronautics, and also at a meeting of the Royal Aeronautical Society, the question of noise was stressed as all important in commercial aircraft. We will quote the remarks of a speaker at the London session:

"I recently had the experience of flying in both the *Hampstead* and the *Argosy* (two big three-engined passenger planes used by the British Imperial Airways) and would say definitely that neither can offer the comfort one gets in an old Ford. As for the noise, I made every possible use of the cotton wool so thoughtfully provided, but that did little good . . . . . Furthermore, there is an engine attached to the nose of the machine and one on either side of the body. The one on the nose makes you aware of its presence by the vibrations it transmits to the passenger cabin, and especially if there should be any irregularities in the firing of the cylinders.

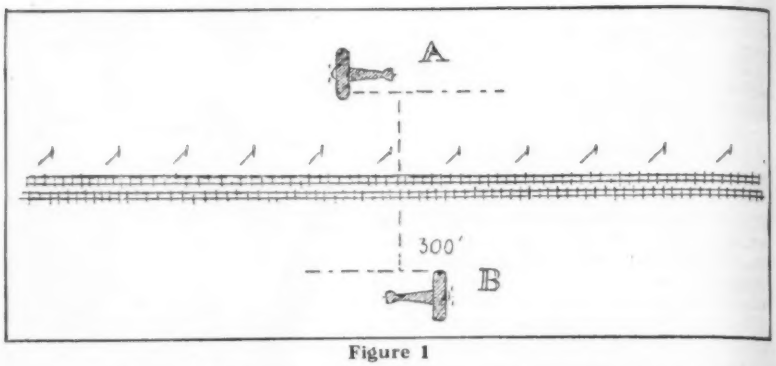


Figure 1

"In my opinion the engines should not be attached to the body, but placed on the wings . . . . . The noise is far too great with them placed as they are, and it would appear that a better position for them would be near the trailing edges of the

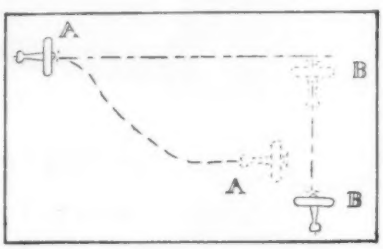


Figure 2

wings, because then the noise would be behind the passengers."

We are heartily in sympathy with these remarks. Other lines of attack in diminishing noise are, possibly: deadening the noise of exhaust by suitable mufflers; geared-down, slow running propellers, with gears which do not contribute noise (perhaps an impossibility); passenger cabins, with noise insulating material, such as cork, air-spaces, et cetera, and the mounting of the passenger cabin in relation to the rest of the machine in such a fashion that noise is not transmitted to the cabin.

Rules of the Air

THE Aeronautics Branch of the Department of Commerce has not only produced some admirable Air Traffic Rules, but in a special bulletin has shown some excellent and easily understood illustrations.

Thus in Figure I, planes must keep to the right of an airway, and when passing each other, flying in opposite direction, they must keep at least 300 feet apart.

In crossing paths, the aircraft which has the other on its right side must keep out of the way. Accordingly, as in Figure 2, *A* must keep out of *B*'s way. The nearest it may approach is 300 feet from *B*. If there is sufficient space, *A* may simply follow the course AA which will bring it back of *B*, which will by that time have proceeded to *B*.

If two aircraft are approaching head-on, each must alter its course to the right, so that each may pass to the left of the other, and so that the two aircraft may be 300 feet apart, as indicated in Figure 3.

In Figure 4, *B*, which is approaching *A* at an angle of less than 70 degrees, is said to be the overtaking aircraft, and must keep clear by altering its course to the right as shown in the diagram, and *not* in the vertical plane.

A similar rule applies when overtaking slower craft.

Other rules provide for a minimum altitude of 1000 feet above a city; a minimum altitude of 500 feet when flying cross-country; no acrobatics over congested areas; no flying under 1000 feet over an open-air assemblage such as a football game.

Landing rules are drawn up with similar logic and clarity. Thus a landing plane

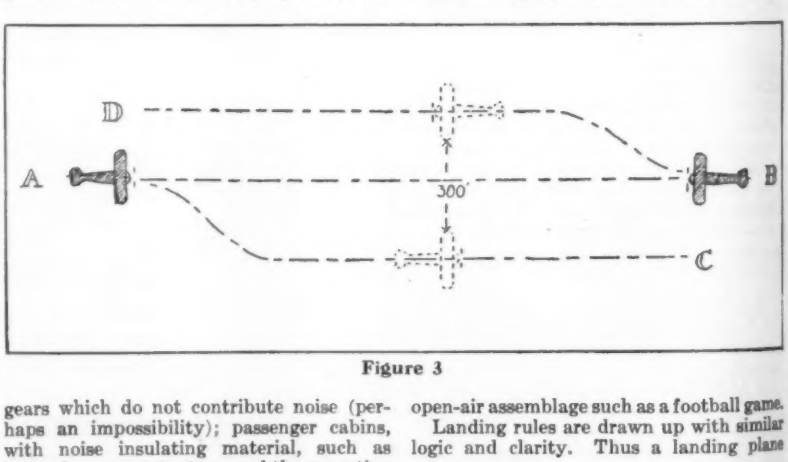


Figure 3

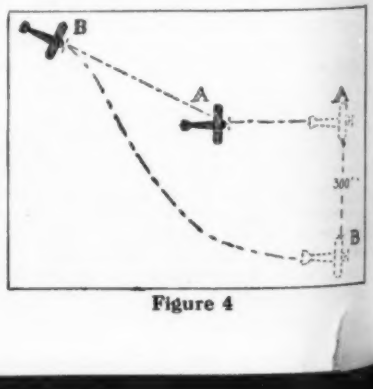


Figure 4

has the right of way over planes moving over the ground or taking off. When landing or maneuvering in preparation for landing, the plane at the greater height must be responsible for avoiding the airplane at the lower height.

An Unparalleled Record

THE Western Air Express, operating an airline between Los Angeles and Salt Lake City has gained an enviable reputation for sound financial and operational management. Its staff of pilots is also unsurpassed. One of this staff, Captain Maurice Graham, has just made a wonderful record. In 13 months service with this company, from April 17, 1926 to May 17, 1927, he has flown 125,000 miles. During this time, Graham has never been forced down by mechanical trouble or weather conditions, has never defaulted a trip and never failed to start on scheduled time. He is to be nominated for the Clifford B. Harmon trophy given for a signal achievement in aviation.

Wide World

Captain Graham, who has made a remarkable aviation record

Municipal Airports in the West

THAT the city airport should be a municipal undertaking is a widely accepted view. The expenditures involved in the construction of municipal airports are large however and the return for many years is problematical. Municipalities for many years have been none too eager to add such projects to their responsibilities. It is therefore gratifying to read that there is immense activity on the Pacific Coast.

Portland has almost completed a 1,250,000 dollar airport; San Francisco has spent nearly 100,000 dollars in improving a temporary field, and contemplates a permanent field to cost 1,000,000 dollars; Oakland has committed itself to an expenditure of 650,000 dollars; Santa Monica has spent 860,000 dollars for a site; San Diego has plans involving 800,000 dollars; and Los Angeles plans to invest 3,500,000 dollars.

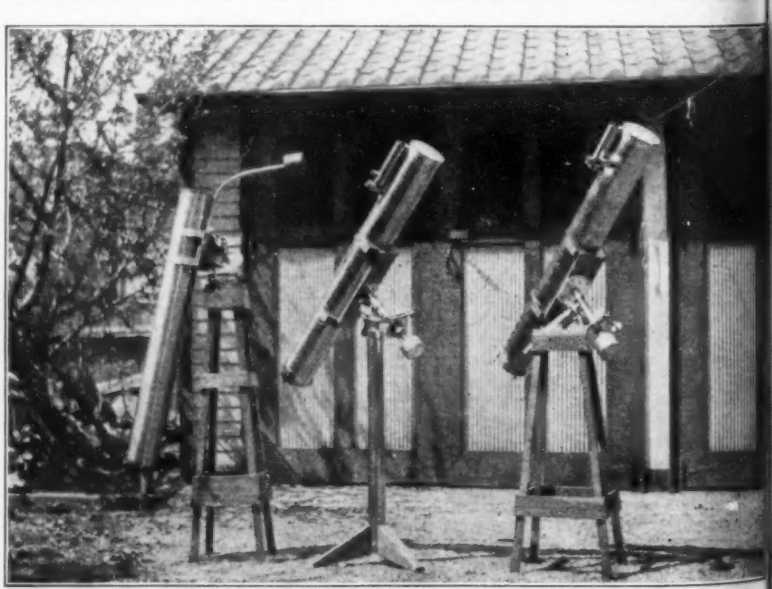
We have received a typical letter from Stockton's Chamber of Commerce, boosting the municipal field with runways of 4000 feet, the ideal flying climate, and the fact that fifty airplanes visited the 177-acre field of this city at its dedication.

It is to be hoped that the city fathers of New York will follow this example.

Telescope Enthusiast Becomes More Enthusiastic

SINCE the publication, a year and a half ago, of the SCIENTIFIC AMERICAN instruction book "Amateur Telescope Making," one amateur, Mr. H. L. Rogers, a real estate broker of 10 Adelaide Street, East, Toronto, Ontario, has actually made his fourth reflecting telescope. Three of his jobs are shown in an illustration reproduced in these columns; his first was described on page 373 of the September, 1926, issue. For his enthusiasm and his evident success we take this opportunity to congratulate this enthusiastic amateur worker on his achievement. It takes some little persistence and dogged "stick-to-itiveness" to complete four reflecting telescopes in one year. And, as his letter indicates, Mr. Rogers is not through yet—he plans to make still another telescope. Who is there among our amateurs who can come forward with a comparable record? Mr. Rogers' letter follows:

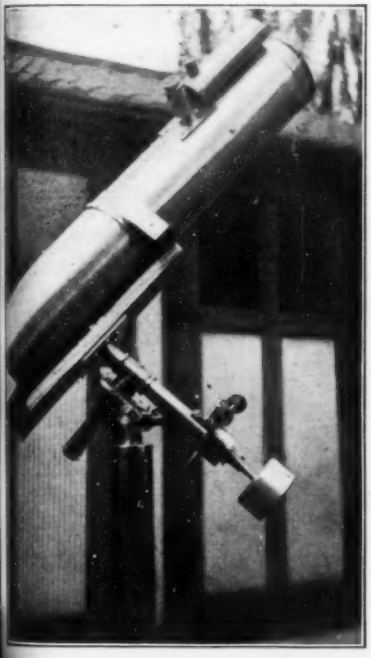
> I enclose two photographs of a very successful telescope which I have made—my fourth, embodying the results of experience gained in making the first three mounts. This mount was made in about six weeks' spare time.
>
> After making a 6-inch Springfield mount, and also a 6-inch Newtonian for a friend, I decided that I would incorporate some improvements—the result of experience—in another telescope, using the laps of two previous 6-inch telescopes for tool and speculum. The photographs will show detail to a considerable extent.
>
> The tube is 24-gauge hard rolled brass with 1½-inch reinforcing bands at ends and cradle. The eye-piece tube carries a helical slot and slides in an outside tube through which a pin projects, giving a nice range for focusing. The mounting is screwed to a sheet brass base let into the telescope, giving a very rigid bearing.
>
> You will notice a very convenient finder made of 2¼-inch brass tube with an opera-glass lens as object glass, and microscope eye-piece of about one inch equivalent focal length. Both telescope and finder have total reflecting prisms instead of silvered flats, there being a noticeable improvement on this account.
>
> The mount is made of two ordinary brass tees with brass and iron piping for axes and bearing tubes. The stand is made of 3-inch polished brass



Three of the four reflecting telescopes built by Mr. Rogers. From left to right, his first, fourth and second instruments. All of them display careful, precise workmanship in their trim, clean-cut construction and assembly

tubing, with an aluminum piston let into each end as filling blocks. This makes an exceptionally firm and good looking mount, free from any springiness and yet light enough to be easily portable.

There is a full 360-degree slow motion on both axes. There is a plate-to-plate friction on the polar axis—the upper one fixed and the lower slow motion plate floating. These plates are held together by a split tubular washer on the end of the equatorial axis, sprung spirally, which gives an adjustable end thrust through a nut on the end of the equatorial shaft. On the declination axis friction is provided through a drum fastened to the floating slow motion plate outside of which is sprung a split 2½-inch tube, which in turn is fastened to the axis. The lead weight is cast around a ½-inch steel rod which slides in the tubular axis. The telescope tube is revolvable in its bearings. This is a very convenient feature.



Close-up, showing details of Mr. Roger's fourth telescope. The finder close to the eyepiece is ideal—no neck-twisting required here

Great care was exercised in proving the figure of the speculum. On the first test the telescope gave a wonderfully clear definition on the moon with ¼-inch eye-piece, magnification about 190. Later, however, I found that there was a slight lateral looseness of the speculum in the cell, and I installed three flat springs designed to hold the speculum central. However, it required a little pressure to press the speculum into the cell and the definition was thereby ruined, evidently straining the glass. It is now an easy fit in the cell and definition seems to be restored. I cannot emphasize too strongly the necessity of getting the speculum to a good parabola and of keeping it free from strain after this is achieved.

I must again pay tribute to your book, "Amateur Telescope Making." It is absolutely indispensable to anyone who would make a telescope. I do not think I have spent, all told, more than 35 or 40 dollars on this instrument. It has provided a very

interesting hobby and promises to be a very useful instrument.

I am still funking any further work on the projected 12-inch job, although the making of it seems less appalling after experiences gained on smaller ones. You can believe me it will be a straight Newtonian with a prism. There will be no Cassegrain or other funny stuff about it.

H. L. Rogers.

"Rolled Their Own"

IF you can not find the price of an airplane and want one badly enough, you can "roll your own" as a last resort. Here is a letter about a man who did just that and apparently did it successfully:

Editor, SCIENTIFIC AMERICAN:

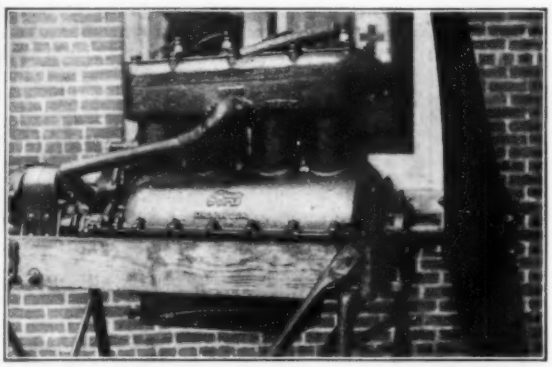
You asked recently if any one has ever put a Ford motor in an airplane. When the writer first came to Fredonia, Kansas, in 1916, he passed a garage and machine shop on the way from the railroad station and seeing an airplane under construction inside went in and got acquainted with the proprietor, Mr. P. P. Belt, who was building it. He found that this was the third or fourth machine Mr. Belt had built, using Ford motors in every one of them.

The first one was an old style Curtis pusher type which Mr. Belt built from the ground up, even to the turn-buckles and propeller. The Ford engine and some Ford wheels for landing gear were the only parts he did not make himself. This machine he sold and then built others. He soon abandoned the pusher type and built tractors, of one of which I enclose a photo. This machine he sold to Paul Neff of Iola, Kansas, who flew it as high as 3000 feet, a Ford motor being the motive power also.

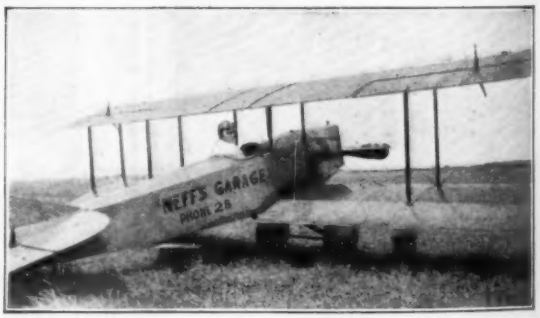
All the machines built by Belt have had nothing but Ford motors, although some were not directly connected to the shaft but had reducing gears. The machine sold to Neff was built in 1919 or 1920. Also enclosed is a photo of one of his converted Fords on a testing block to test before installing. Mr. Belt, we have good reasons to believe, is the first man in the world to fly an airplane with a Ford motor.

F. H. Marshall.

Fredonia, Kansas.



A standard Ford motor that has been rebuilt for use in an airplane. A few minor alterations were made on the motor itself. In this particular engine, shown here on the testing block, the propeller was bolted directly to the crank-shaft. In some other models, reducing gears were employed



A tractor type of airplane equipped with a Ford motor, built by Mr. P. P. Belt, of Fredonia, Kansas. The engine is housed in the forward end, being entirely enclosed and protected from the weather. The radiator for cooling is in the front of the fuselage

Problem

READERS who enjoy working out geometrical problems may take joy in tackling the one outlined below. Kindly send replies direct to Mr. Melhase.

Editor, SCIENTIFIC AMERICAN:

I am enclosing herewith a diagram illustrating the kite-shaped race track. As shown thereon, the track consists of two tangents each 1760 feet in length, intersecting at B and connected by a circular arc also 1760 feet long, so that the entire course is 5280 feet in length.

The problem in laying out this course lies in finding the angle A and the radius R, which, so far, I have been able to do only by the trial and error method.

I submit the problem in the hope that some of your readers, mathematically inclined, may be able to furnish a solution.

John Melhase,
875 Vincente Avenue.
Berkeley, California.

Jap

HERE is a short letter from a Japanese schoolboy. How many of us Yankees will volunteer to compose as good a letter in Japanese?

Editor, SCIENTIFIC AMERICAN:

Please allow me to write a letter to you to introduce. I know your name in the SCIENTIFIC AMERICAN magazine and you are a president of your office. I am a reader of your magazine, and I take this magazine before long time ago at the Department Store in Tokyo City. At once I found it very interesting scientific magazine

in which the photograph of Scientific is very useful for me. Always I was charmed with it. This time I should like to exchange the picture post-card and postage each other of American boy and girl, but I don't know how to exchange of it each other, so I should like to beg you, will you kindly to introduce for me whom liked to exchange American boy and girl? So we will have exchange the card and other thing each other. If it was done so, how I was glad with it.

Now I am going to middle school at night course. I have one friend of American boy we met him each other at the church every Sunday and we have spend rejoicing each other.

At the end, I cannot understand so well in English. If there are any mistakes please you may give to understand.

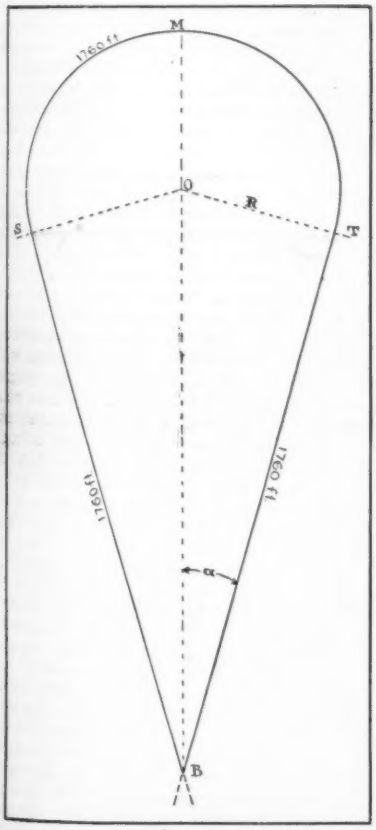
I am,
Dear Sir
Yours very truly,
T. Mori.
c/o The Banks of Japan, Tokyo, Japan.

To this we replied:

Dear Mr. Mori:

If we were "American boy or girl" instead of a gray-haired, hard-boiled editor we should like to exchange picture post-cards with you. Some of our younger readers will want to correspond with you, we are sure. Do not apologize for your lack of understanding of the English language. You write English far, far better than we shall ever be able to write Japanese.

The Editor.



A pretty problem in mathematics is presented by the design of a kite-shaped race track of the type shown above. The details of it are contained in a letter published on the opposite page

Applied Science for the Amateur

(*Continued from page* 464)

up very realistically by gluing together small pieces of soda fountain straws. Numerous other forms, such as streamlined head rests, propeller caps, et cetera, may be formed out of "plastic wood." This is a very useful product obtainable at some hardware stores. This material is something like putty and can be molded into any form but when hard it resembles wood and can be carved or painted.

How to Make a Model Glider

DEFINITION: A glider is an aircraft which is heavier than air and has no inherent power plant.

Appearance: A glider consists of a frame and wings. Many gliders resemble ordinary airplanes without power plants but some are radical in design.

Operation: A glider is launched from an eminence and moves through the air impelled by its initial starting impulse and by the attraction of gravity. A glider coasts upon the air. In other words it combats the attraction of gravity with the support derived from its wings. Because a glider weighs more than the surrounding air it is always falling through the air, but it may encounter a rising current of air which will lift it upward, or in still air it will coast at a descending angle, moving forward many feet, while it is falling one foot. The duration of a glide depends on the initial launching elevation and velocity, the buoyancy of the surrounding air, the construction of the glider itself, and the kind of ground over which the glide is made.

Construction: Gliders are designed to move in one direction, namely, forward and slightly downward. Air conditions may cause them to depart from this position, but the glider should be inherently stable and so designed that it will regain its correct attitude, otherwise it will rapidly lose its elevation. The correct nose-down position is obtained in two ways; either by providing less lifting surface in front than in the rear, or by weighting down the nose slightly.

An elementary glider having the small wing in front can be made as follows: Procure a piece of stiff thin cardboard or wood veneer ten inches long and five inches wide. Procure also a piece of wood one quarter inch square and one foot long, two small rubber bands, and a piece of small stiff wire about two inches long. Cut from the cardboard or veneer two rectangles, one to be ten inches by two and one half inches and the other to be six inches by one and three quarter inches. These are the wings. Cut another piece two inches square and round off one corner of this to form the rudder as shown in the side view in the drawing. The same view also shows a wedge for elevating the wing. This wedge is made by cutting off one inch of the stick and cutting it in half diagonally. The wire is bent into the shape shown for the hook and is bound to the front of the stick. In the rear of the stick, a saw-cut two inches long is made and the rudder inserted and glued or nailed in that cut. The wings are slightly curved as shown in the side view and placed on the glider approximately in the positions shown in the top view. They are secured with rubber bands as shown in the detailed drawing in the right hand upper corner. This completes the glider itself.

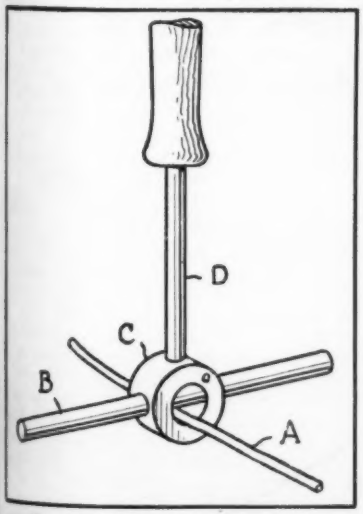
It is launched by use of a sling. To

construct this, procure a crotch from a small tree limb and to the upper ends of the crotch bind a one foot length of strip rubber, which may be obtained either by linking up rubber bands or by cutting a strip from an old inner tube. To launch the glider, hold it by the rudder in the right hand with the sling held in the left hand. By stretching the rubber and releasing the glider, it can be made to make long glides and may be adjusted to do several aerial maneuvers.

In addition to constructing an efficient glider, you must learn how to launch it properly. Even the best glider will not perform well unless properly placed in the air. You should experiment with your glider and determine the most efficient arrangement of the wings and weights. When this arrangement has been found, the placement of each part should be carefully marked in order that the glider may be always placed in the most efficient condition. The stipulations of contests with these gliders should decree that the launching must not be above six feet from the floor. Because gliders are capable of going the greatest distance forward when their original elevation is the highest, every contestant should make sure that he has the maximum elevation of six feet from which to launch his glider. If the contestant be so short that he cannot reach this elevation, he should stand on a chair or some other object. A horizontally suspended string at the exact height of six feet would be a good means of indicating the proper elevation. In launching the gliders, it will be found that they will perform the best when they are not thrust forward into the air but rather laid on the air with a gentle push inclining the nose slightly downward. It is remarkable what long glides can be obtained from an efficient aircraft. A reasonably good glider should be able to go forward twelve feet to every foot that it drops.

Holder for Wire Solder

A HOLDER for two thicknesses of wire solder, made as shown in the accompanying illustration, is a useful tool for the repair shop writes H. Moore in *Machinery*. Many tinning and joint sweating jobs require varying amounts of solder during the procedure of the work, and it is sometimes difficult to apply just the right amount un-



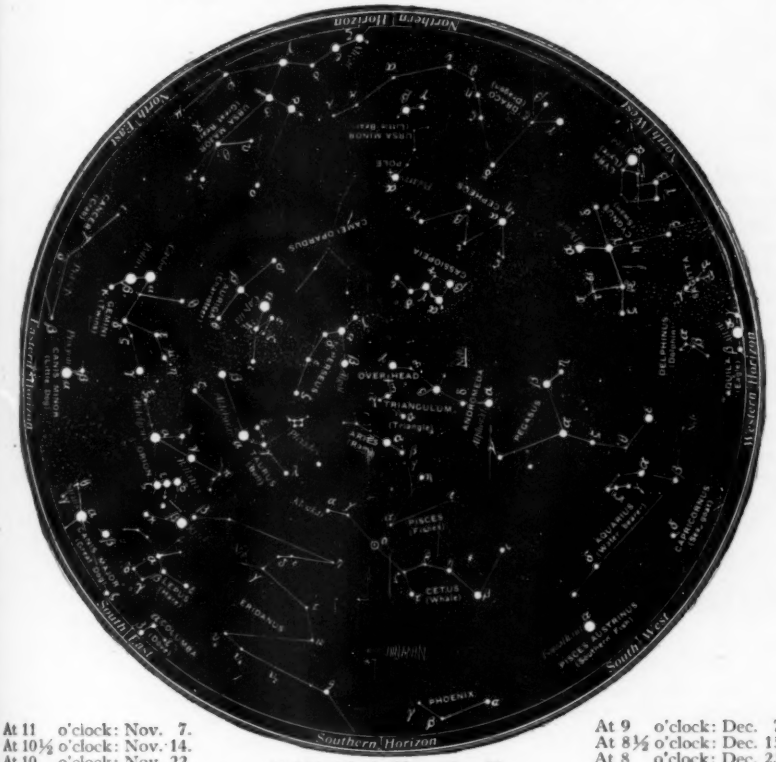
Simple holder for wire solder

less two sizes of solder are used. If a small quantity is required, the thin wire *A* is applied to the work, and if a larger quantity is needed, the thick solder at *B* is applied by turning the holder.

To make the tool shown, a collar *C* of suitable size is obtained, and a hole large enough to fit the large size solder is drilled through the collar. Then at right angles to the first hole is drilled a smaller hole which is tapped to receive the threaded end of the short rod *D*. The wooden handle is driven on a tang ground on the projecting end of rod *D*. The thick piece of solder *B* is passed through the drilled holes, and the thin piece *A* through the bore of the collar. By screwing rod *D* into the collar, both pieces of solder are secured in place.

The Heavens in November

By PROF. HENRY NORRIS RUSSELL, Ph.D.



At 11 o'clock: Nov. 7.
At 10½ o'clock: Nov. 14.
At 10 o'clock: Nov. 22.

At 9½ o'clock: November 30.

At 9 o'clock: Dec. 7.
At 8½ o'clock: Dec. 15.
At 8 o'clock: Dec. 23.

NIGHT SKY: NOVEMBER AND DECEMBER

The Heavens

As our map shows, the finest part of the sky is in the east and southeast, where we find the Giant and Little Dogs low down, Orion and Gemini, the Twins, about them; and Taurus and Auriga higher still. Perseus and Andromeda are nearly overhead, Pegasus high in the west, Cygnus and Lyra in the northwest, Cassiopeia and Cepheus high in the north and the Bears and Draco the Dragon, below them. Eridanus and Cetus occupy the dull region in the South.

The Planets

Mercury is an evening star until the 10th, and a morning star after that date. He may be seen just before dawn toward the end of the month. Observers in the Eastern Hemisphere will have a much more interesting chance to behold him on the 10th when he transits across the sun's disk almost centrally, taking more than five hours to cross it. He enters upon the sun at 10:02 P. M. on the 9th (by Eastern Standard Time) and leaves it at 3:29 A. M. on the 10th, so that the American continent is turned away from the sun during the whole of the interesting transit.

Venus is a morning star and is at her greatest apparent distance from the sun on the 21st. At this time she rises about 2:30 A. M., and she is extremely conspicuous all through the month.

Mars is a morning star very close to the sun, and practically invisible.

Jupiter is due south at 9:00 P. M. when the month begins, and at 7:00 P. M. when it closes, and is prominent all the evening.

Saturn is an evening star visible just after dark early in the month, but lost in the twilight before its close.

Uranus is not far from Jupiter, and observable in the evening.

Neptune is in quadrature on the 22nd, and can be observed in the morning.

The moon is in her first quarter at 10:00 A. M. on the 2nd, full at 2:00 A. M. on the 9th, in her last quarter at 1:00 A. M. on the 16th, and new at 5 A. M. on the 24th. She is nearest the Earth on the 12th, and farthest off on the 21st. During the month she is in conjunction with Jupiter and Uranus on the 5th, Neptune on the 16th, Venus on the 19th, Mercury on the 22nd, Mars on the 23rd, and Saturn on the 25th.

OUR CHOICE OF RECENT BOOKS

Science: Leading and Misleading

By Arthur Lynch

A rather tart but not venomous attack, chiefly against shams in modern science. Many scientists of third and fourth rate follow the leader, blindly, like sheep. Thus there are styles in scientific thought—sometimes fads (any true scientist knows this). However, this is not one of the recent crop of bitter, provoking books written by anti-science cranks, but was written by a scientist who knows, from an inside point of view. Sweeping the whole field—mathematics, relativity, physics, chemistry, biology, psychology, medicine—he places a heavy hand on some existing sore spots and wiggles it sometimes rather ungently. Both the professional scientist (genuine) and the intelligent layman who keeps up with science and knows who the proponents of the leading theories are, will find this work of criticism well worth pondering.

E. P. Dutton & Company. $3.15 Postpaid.

General Chemistry

By T. P. McCutcheon, Prof. Inorganic Chemistry, Univ. Pennsylvania. H. Seltz, Asst. Prof. Physical Chemistry, Carnegie Institute

A treatment in two divisions. First, a concise and orderly summary of chemical facts emphasizing the natural groupings and relationships under the Periodic Law. Second, the essentials of theoretical chemistry each complete and free from irrelevant matter.

D. Van Nostrand Co. $3.65 Postpaid.

Acetate Silk and Its Dyes

By C. E. Mullin

Of special interest to all users of cellulose acetate and acetate silk as well as dyestuffs and dyeing. This latter portion of the book deals with several classes of dyestuffs which hardly receive mention in any other book in any language. Patent abstracts give invaluable aid to the research worker, along the lines of the rayons or dyestuffs.

D. Van Nostrand Co. $6.20 Postpaid.

Modern Electrical Illumination

By C. Sylvester, T. E. Ritchie

A complete treatise on almost every form of commercial, industrial and social illumination. Lighting designs and examples of good and bad systems are shown with advice as to why and how certain methods will give superior results. Abundantly illustrated. A splendid example of meritorious book-work.

Longmans Green & Company. $15.00 Postpaid.

History of the Explosive Industry

By A. P. Van Gelder, H. Schlatter

This is not a text-book of manufacture, though technical development is treated somewhat in detail, it is a running narrative obtained through interviews and correspondence, research in colonial archives and those of the powder companies and a digest of the most important credited data that can be obtained. A much needed and important contribution.

Columbia University Press. $10.52 Postpaid.

Modern Automobile Painting

By M. J. Pearce

The literature on this subject is very meagre indeed. More progress has been made in automobile painting in the last few years than during any similar period in the industry. This book will therefore be a most helpful guide to anyone interested in motor car finishes.

David McKay Company. $3.15 Postpaid.

Statesman's Year Book

M. Epstein, Editor

The sixty-fourth issue of this compendium of statistics for all the countries of the world. Invaluable as a reference wherever accuracy of fact is of first importance, as the revisions have included the latest details with regard to political divisions and data?

The Macmillan Company. $7.70 Postpaid.

Commercial Property News

A Department of Facts and Notes of Interest to Patentees and Owners of Trademark Rights

CONDUCTED BY MILTON WRIGHT

The Stillson Wrench Case

"IF it isn't an Eastman it isn't a kodak." No manufacturer save Chesebrough may use the term "vaseline" for his petroleum jelly. None but the Celluloid Company may call its product "celluloid." Anybody, however, may now make wrenches and call them "Stillson."

Although the Walworth Company is the originial manufacturer of the famous Stillson wrenches, although it is the only manufacturer ever authorized by Daniel Stillson, the inventor, although it has manufactured wrenches called Stillson constantly since 1869, under the trademark "Stillson," and although its trademark has been registered in the Patent Office for the last 21 years, the United States Circuit Court of Appeals for the First Circuit proclaims the word not properly registrable and cancels the Walworth's registration on the ground that it was obtained in 1906 by misrepresentation and fraud.

The decision affirms the lower court's decision in the suit for infringement brought by the Walworth Company against the Moore Drop Forging Company. Among other things the court says:

"In October, 1904, the defendant began the manufacture of the Stillson wrench on a large scale. Over 1000 such wrenches were shipped prior to February 15, 1905, marked 'Stillson Wrench Made by Moore Drop Forging Company, Springfield, Mass., U. S. A.' Defendant continued its business uninterruptedly and without protest from the plaintiff until this suit was filed (without prior notice to the defendant) on May 5, 1925. Evidence indicates that the defendant has manufactured and sold 5,000,000 of such Stillson wrenches during this period of about 21 years, involving a business of about 4,000,000 dollars.

"The court below, in an oral opinion, delivered apparently at the close of the trial, held that Stillson as applied to the wrench when the plaintiff began to manufacture it under the Stillson patent was purely a descriptive word indicating the construction of the wrench; that, while the registration was *prima facie* evidence that the word had attained a secondary meaning as indicating a wrench made by the plaintiff, it was still a question of fact as to whether the *prima facie* case made by registration was overthrown by the other evidence in the case. The court held that it was 'so overthrown,' and that, on all the evidence, the word Stillson was never used by the plaintiff as a trademark. That court also held that even if there were a trademark, the defendant had not infringed as the evidence showed that all the wrenches put out by the defendant were marked 'Stillson Wrench Made by Moore Drop Forging Company.'

"The court below found, on all the evidence, that the plaintiff was not the exclusive user of the word Stillson as applied to wrenches at the time when it applied for the trademark upon which this suit is based, and that on this additional ground the registration was fraudulently obtained by the plaintiff; he, therefore, sustained the counter-claim; dismissed the bill with costs; and referred the case to a special master to state the damages (which he finds to be substantial) suffered by the defendant by reason of the fraudulently obtained registration.

"It is too plain for argument that these findings are fully supported by evidence, practically uncontradicted and unmodified."

Claims May Be Too Broad

SOMETIMES an inventor will claim too much under his patent. In such a case, should there be litigation, the courts have two alternatives: to limit the claims to a narrow interpretation, or to recognize the wide scope of the claims and hold them invalid for lack of invention.

The suit brought recently by the Richardson Company and James C. Woodley against the Hood Rubber Company is a case in point. The plaintiffs complained of the manufacture by the defendant of boxes for storage batteries to be used with automobiles. These were made of a bituminous compound consisting of asphalt, asbestos and a kind of cotton waste, and were molded while the composition was in a plastic state. The patent in suit was for a "fibrous composition and process of manufacture" especially applicable to roofing.

The inventor described his patent as follows:

"I have described my product with particular reference to making roofing sheets in rolls, but it may be produced in the form of shingles, flat sheets, tiles, et cetera. Also, on account of the superior strength, insulating and wearing properties of my composition, I may employ it advantageously in other arts, as for example, in making paving blocks, floor tiles,

Patents Recently Issued

Classified Advertising

Advertisements in this section listed under proper classifications, rate 25c per word each insertion; minimum number of words per insertion 24, maximum 60. Payments must accompany each insertion.

Official copies of any patents listed in this section at 15c each; state patent number to insure receipt of desired patent copy.

Pertaining to Aeronautics

AIRPLANE CONSTRUCTION—In which a relatively small propeller is used as an auxiliary directly in front of the inactive area of the regularly used, larger propeller, thus increasing speed. Patent 1637398. M. Syracusa, 1641 So. California Ave., Chicago, Ill.

Pertaining to Apparel

HOSE SUPPORTER—An elastic member which will act to tighten the top of the hose against the leg and thereby produce a supporting action. Patent 1637948. S. Kurzer, 23 Fulton Ave., Middle Village, N. Y.

UNION SUIT—Formed of woven substantially non-elastic fabric, an elastic waist band formed of knitted fabric, with the upper body portion and neither portion connected thereto. Patent 1638592. H. F. Monheimer, c/o Munn, Anderson & Munn, 24 West 40th St., New York, N. Y.

MOLDED-FLANGE INSOLE—Producing an upstanding flange substantially at the insole periphery, for the purpose of making room for the stapling anvil of a lasting machine. Patent 1638705. A. H. Prenzel, Halifax, Pa.

HEADDRESS—Having novel means for adjusting the head encircling parts, and so constructed that distinctive ornaments may be worn in combination with the headdress. Patent 1638756. H. Wallman, 66 Franconia Ave., Flushing, N. Y.

Chemical Processes

MINERAL FEED AND PROCESS OF PREPARING THE SAME—A mineral feed for domestic animals, which does not dry out, consisting of the following ingredients, treated rock phosphate, limestone, salt cake, charcoal, common salt and water. Patent 1637428. V. R. Rupp, c/o Moorman Experiment Station, Moorman Mfg. Co., Quincy, Ill.

Designs

DESIGN FOR AN ORNAMENT FOR RADIATOR CAPS—Patent 72934. A. Cheron-Duval, 6424 Yucca St., Los Angeles, Calif.

DESIGN FOR A WOVEN FABRIC OR SIMILAR ARTICLE—Patent 73022. L. Gluhm, % Phoenix Mfg. Co., 40 Thomas St., New York, N. Y.

DESIGN FOR A FINGER RING—Patent 73107. M. E. Soman, % D. A. Walters, 2 W. 45th St., New York, N. Y.

DESIGN FOR A GAME BOARD—Patent 73103. W. Rowe, 511 W. 60th St., Chicago, Ill.

DESIGN FOR A DRESS.—Patent 72923. J. C. Worth, c/o David Crystal Inc., 1351 Broadway, New York, N. Y.

DESIGN FOR A CURTAIN-POLE—Patent 73131. W. F. Hofmann, % H. L. Judd Co., 87 Chambers St., New York, N. Y.

DESIGN FOR A CURTAIN CRANE—The inventor has been granted two patents for ornamental

floor coverings, storage battery containers, pipes or conduits, electric insulating, et cetera. I may also, if desired, incorporate with my material coloring matter or mineral or other filler."

Commenting on this, Judge Lowell of the Massachusetts Federal District Court, says:

"This is merely the expression of the patentee's day-dream—an inventor's 'castle in Spain.'"

The court contrasts the roofing and the battery box and dismisses the complaint, saying:

"After a careful consideration of the terms of the specification I have come to the conclusion that the claims do not cover the process of manufacture of a firm, acid-resistant battery box such as the defendant makes. This result is safer for the plaintiffs, as it saves them from the danger of having their patent, if it were more broadly interpreted, declared invaild for lack of invention."

Hokum Patents

"HOKUM—a word, act, business or property used by an actor to win an audience."—"The Desk Standard Dictionary."

A song is not getting across the footlights very well; the audience is apathetic. In the last stanza the singer waves the American flag. The audience cheers and the act is a success, or, as they say on Broadway, a "wow." That flag-waving is *hokum*.

There is, of course, plenty of hokum in business, too. Sometimes a patent is the "word, act, business or property used to win an audience," or prospective purchaser. For example:

The writer recently was chatting with the president of a company engaged in construction work in which patented products are installed. His chief competitor is one of the biggest organizations of manufacturing engineers in the country.

"The big fellows are making it mighty hard for us." said our friend.

"How come?" we asked, using a current slang phrase.

"Well, they have a patent. Scientifically it is worse than useless, but from a business standpoint it is a winner. Our unpatented product is better than theirs; our price is lower; our service is as good or better; but that patent has us stopped."

"Why?"

"That company deliberately will change a product for the worse for the sake of getting a patent. They will make changes and innovations that they know—and their engineers are among the best in the United States—are not in the line of improvement, just so they can have a monopoly in something. Never mind how much merit the invention has or has not."

"But what good does the patent do them?"

"It is a sales argument. They flaunt that patent before a prospective customer and he thinks there must be some special merit in the product if they are so proud of it. Perhaps the prospective customer says, 'But your competitor says his unpatented product is better than your patented one.' They come right back at him with, 'Of course, he claims that. But he couldn't use a product like ours if he wanted to, could he? We are the only people who can give you this patented product.'

"Now what comeback have we in a case like that? We can argue until the cows come home and it will do no good. The patent has us licked."

All of which goes to illustrate the truth that where something has its uses it has its abuses, too, and that patents have features that Thomas Jefferson probably never thought of when he was Patent Commissioner.

While a Reissue Patent Is Pending

A MAN patents an invention, and after obtaining his patent discovers it is advisable to apply for a reissue of the patent. Before he gets his reissued patent, however, another man infringes the claims of the pending reissued patent, but not of the original patent. Can the patentee recover damages?

Such was an issue in the recent case of the Bull Dog Floor Clip Company against the Munson Manufacturing Company before the Circuit Court of Appeals for the Eighth Circuit. The patent covered a metal device for use in holding flooring sleepers in place on a concrete base. Says the court:

"The evidence shows without dispute that after reissue of the Prickett patent, defendant sold 150,000 of the clips, Exhibit 16, which I have held to infringe claims 4 and 5 of the reissue patent, but not to infringe the original patent.

"The evidence shows that all of these clips were made by defendant during the summer of 1922 and nearly two years before the reissue was granted, and were sold after the reissue of the Prickett patent.

"It also shows that defendant applied to its attorney for an opinion as to the coverage of the Prickett patent and was advised that it did not cover the clip Exhibit 16. Apparently Cole was willing to rely upon the advice of his attorney, and, as the conclusion reached by the special master is that the clip Exhibit 16 did not infringe the original Prickett patent, it must be held that defendant had the right to dispose of the 150,000 old clips remaining on hand after the reissue."

Patents for Useful Designs

CAN a man get a design patent on an invention made primarily for purposes of utility rather than invention? The Primary Examiner thought not, and therefore refused a design patent to Alphonse F. Pieper on a universal joint. The Examiners-in-Chief thought differently, however, and reversed the decision, saying:

"It does not necessarily follow that because an article may serve a utilitarian purpose it cannot be ornamental. In the design of the instant application we find evidence that the universal joint shown was given its particular shape because of a desire to secure an ornamental appearance. Appellant states in his brief that the joint disclosed is primarily intended for use in association with apparatus employed in dental parlors where an appeal to the esthetic sense is desirable. That appellant's design is ornamental is evident, we think, on comparison with the universal joint of the mechanical patent to Wilkinson. As a mechanical structure, appellant's device is probably no better than that of the patent, but so far as ornamental appearance is concerned there is no doubt as to which is the more desirable."

Electrical Devices

RADIO TUNING DEVICE—In which the dielectric losses are reduced to a minimum, the distributed capacity low, and the eddy current losses considerably reduced. Patent 1637923. H. F. Venzke, Boyertown, Pa.

INDUCTANCE—In which the winding is so arranged as to minimize the effective electromagnetic field, whereby two or more inductances may be placed in close proximity. Patent 1637649. S. Kurka, 1636 So. Harding Ave., Chicago, Ill.

LAMP-SOCKET CONSTRUCTION—A resilient mounting, particularly adapted for Christmas tree lamps, whereby when the filament of any one of a plurality of lamps is broken, it can be quickly discovered. Patent 1638691. L. A. Hofstetter, 22 46th St., Union City, N. J.

SHIELD FOR USE IN THE PRODUCTION OF RADIOSCOPES OR RADIOGRAPHS—Comprising a circular frame, strip-shaped blades of X ray opaque material mounted therein, and having one fixed to the frame, the other free to vibrate. Patent 1638683. M. Demarchi, c/o G. Capuccio, Via Arsenale N. 17, Turin, Italy.

Of Interest to Farmers

ORCHARD HEATER—Of simple construction, adapted for the use of a liquid hydro-carbon and having means for partially vaporizing the fuel and for carbureting the fuel vapors. Patent 1637983. J. C. Beckley, c/o Am. Welding & Tank Co., Tampa, Fla.

HOG WATER FOUNTAIN—For use in hog pens, there being an arrangement of pans to hold mud, and valves to prevent the mud from entering the float chamber. Patent 1637940. M. J. Hosch, Randolph, Neb.

Of General Interest

COMBINATION CIGARETTE OR CIGAR AND MATCH—The combination being in such manner that the match may be easily disassociated without injury to the cigar or cigarette, and ready for lighting. Patent 1635967. F. Stone, Rosalia, Wash.

SAFETY DEPOSIT RECEPTACLE—A portable receptacle by means of which a traveler in a public conveyance, such as a train or boat, may protect his valuables against theft. Patent 1634884. E. S. Peer, P. O. Box 1367, Station "C" Los Angeles, Calif.

TEMPORARY BINDER—Capable of securely holding magazines, catalogues and similar publications, of various forms of binding, such as center or side wire stitched, or sewed. Patent 1633070. F. H. Crump, 225 E. 4th St., Los Angeles, Cal.

COMPACT EJECTOR FOR VANITY CASES—Wherein a swinging bar extends normally across the bottom of the vanity case and acts to swing the compact carrying plate out of the case. Patent 1635891. W. G. Kendall, 118 Market St., Newark, N. J.

REENFORCED AIR HOSE—Such as is used in mine ventilation, having continuous external flexible suspension flange, with connecting strips secured to the tube. Patent 1635957. A. S. Richardson, 1238 W. Granite St., Butte, Mont.

BERRY BOX—Which may be formed from wood, card-board or similar material from one piece folded to make the complete box. Patent 1636306. H. F. Keller, Jr., Longmont, Colo.

DESIGN FOR A CURTAIN-POLE END—The inventor has been granted three patents for ornamental designs. Patents 73178, 73179 and 73180. W. F. Hofmann, c/o H. L. Judd, 87 Chamber St., New York, N. Y.

DESIGNS for curtain cranes. Patents 73165; 73166. A. Dlouhy, c/o H. L. Judd Co., 87 Chamber St., New York, N. Y.

CORNICE BLOCK—Designed for strengthening and holding hollow terra cotta, or artificial stone cornice-forming blocks, when first assembled and after they have been set. Patent 1635893. J. Lynch, 619 Carson Ave., Perth Amboy, N. J.

WALL BOARD—A composition board, for use in facing walls, so constructed that when a plurality are used the seams will be effectively concealed. Patent 1635922. P. T. Beygrau, 1049 Keith Ave., Berkeley, Calif.

VANITY-CASE HINGE—In which practically all of the parts are arranged interiorly of the casing, so that the exterior is left smooth and even. Patent 1635941. W. G. Kendall, 118 Market St., Newark, N. J.

CREEL CARRIER—Adapted to be supported either on the back or at the side of the wearer and carried comfortably, adjustable to various sized wearers. Patent 1635928. W. R. Davis, Wallace, Idaho.

UNIVERSAL JOINT—Which will enable the utmost relative flexibility and a wide range of variation in the position the parts can assume, as the elements are manipulated. Patent 1635164. N. W. Amdur, % Sun Ray Lighting Products Co., 119 Lafayette St., New York, N.Y.

SYSTEM OF TAKING PHOTOGRAPHIC AND CINEMATOGRAPHIC PICTURES—In composite form, by which objects of different scale are united within the camera by means of a mirror or series of mirrors. Patent 1636112. E. Schufftan, Kaiser Alles 79a, Berlin, Friedman, Germany.

LOAD BINDER—Which will permit of instantaneous locking of the binder and equally quick taking up of the slack cable, yet the lever may be easily opened by hand. Patent 1636638. F. A. Jenkins, Box 115, Older, Texas.

BUNG-PLUG LOCK—For bung plugs of steel drums, to prevent theft when they are ungarded on loading platforms, in the fields, or other places. Patent 1636641. B. F. Lewis, % Olga Garage, Olga, Fla.

CRATE—Constructed to permit the stacking of a large number in a freight car on in storage without liability of the fruit or contents being damaged. Patent 1636607. J. S. Horton, Laurel Del.

SHINGLE—Of the lock-down type, which may be cut from a roll of roofing paper, insured against curling, and secured by a single nail. Patent 1637306. J. E. Hooker, Box 475, Coral Gables, Fla.

HAT BOX—Arranged to carry ladies' hat as well as other articles of clothing without damage to the hat or other articles. Patent 1637223. J. A. Holtzman, 215 W. Baltimore St., Baltimore, Md.

CABLE GUARD—For supporting a cable on a post, wherein an adjustable bracket is used to support the cable in spaced relation and at proper tension to the post. Patent 1637241. I. E. Quist, Warren, Minn.

PAN LIFTER—Which can be easily placed in engagement with, or disengagement from a hot pan, for lifting the same without injury or discomfort. Patent 1637227. A. R. McDaniel. Johnstown, Neb.

METHOD OF PRODUCING THE SHELLS OF METAL BOXES—From sheet metal, and incorporating an ornamental design, without distorting the members of the blank, as employed in the production of vanity cases. Patent 1637242. A. F. Reilly, % Evans Case Co., No. Attleboro, Mass.

CROSS-JOINTED METAL BAR—Wherein part of one bar is cut and pressed into a bracing of the other bar, none of the metal being removed, for use with metal window sashes. Patent 1637220. S. J. Gary, 3242 De Catur Ave., Bronx, N. Y.

FLOORING TILE—Which will be free from pot marks, have a hard surface which will not allow dirt to be readily ground in, may be easily washed, will hold its original color and will have maximum strength and wearing qualities. The inventors have been granted two patents 1637301 and 1637302. G. C. Hannam and J. W. Schede, 1 Madison Ave., New York, N. Y.

METHOD OF MAKING IMITATION MARBLE—Which comprises forming a mold with a glass bottom, coating the glass with colors to produce veining and pouring in a body layer of concreting mixture. Patent 1637946. K. R. Knofe, address Trygve Mamen, c/o Carl Fisher, Port Washington, N. Y.

PROTRACTOR—For plotting and measuring angles, whereby the scale of graduations is doubled so that the readings are caused to be much more accurate. Patent 1637933. C. B. Galvin, 448 Central Park West, New York, N.Y.

COMBINED HAND MIRROR AND TABLE MIRROR—In which the handle portion may be rigidly coupled to the frame to define a handle, or locked in folded position to constitute an easel. Patent 1638672. J. J. Walsh, 246 N. Broadway, Yonkers, N. Y.

INSECT CATCHER—Which may be used for catching insects alive without crushing them, as with a fly swatter, and for trapping them until desired to remove them. Patent 1638690. C. Y. Hake, 1450 Mt. Rose Ave., York, Pa.

REFRIGERATOR AND DISPENSER—For holding a plurality of bottles in position to be affected by a refrigerant, and so that they may be removed without outside air gaining entrance. Patent 1638181. G. C. Bell, 1219 Hichman Rd., Augusta, Ga.

SKYLIGHT—Which has a metalic frame and is of fire-proof construction, and in which the respective members brace one another forming a durable structure. Patent 1638668. S. Volk, 122 Water St., Benton Harbor, Mich.

FASTENING DEVICE—Especially adapted for use in connection with loose leaf-binders, also adapted for use as a fastener for papers, the parts being held against displacement. Patent 1638763. G. H. Ennis, 1812 Harrison Ave., New York, N. Y.

PENDANT ORNAMENT—To be worn suspended around the neck, may be unfolded and displayed as a cross, or folded to form a cube. Patent 1638743. G. W. Peterson and B. T. Walls, c/o B. T. Walls, 1210 E. 16th St., Long Beach, Calif.

UMBRELLA COVER, RIB AND STICK CONNECTION—And means for readily associating the elements specified so that they may act as an emergency water protection means. Patent 1638764. F. Fabbrin, c/o Continental Products Corp., Att. J. W. Miller, 165 Broadway, New York, N. Y.

TRANSPLANTING DEVICE—Designed for use in removing plants from pots to the ground without injury to the roots, the earth surrounding the roots remaining in compact form. Patent 1638693. B. Hooks, Thomas, Okla.

ANIMAL TRAP—Especially for catching mice and rats, the trap cannot be robbed without the animals being caught, there is no trigger mechanism to get out of order. Patent 1638767. W. I. Harmon, Langley, Wash.

DRY FIRE EXTINGUISHER—In which an extinguishing powder is driven in the form of a jet from a receptacle by means of gas under pressure. Patent 1638729. W. Friedrich, Guericke Str. 21, Jotelhaus, Berlin, Charlottenburg, Germany.

PAVING BLOCK—Comprising a metal plate having upon its under side downwardly extending lugs and anchorage members, for forming traffic control lines in roadways. Patent 1638744. T. J. Priestman, c/o H. J. C. Forrester, Jessel Chambers, 88 Chancery Lane, London, W. C. England.

Hardware and Tools

CAN OPENER—That may be used with safety for cutting the end of a can without liability of the cut edge inflicting injury to the hands. Patent 1636785. A. W. Peterson, 1533 E. 74th St., Chicago, Ill.

BOILER TOOL—An attachment for power-driven rotary device which will function to screw a socket into a boiler sheet without exerting any pressure with the end of the socket member. Patent 1637949. H. A. Lacerda, 330 1st Ave., Watervliet, N. Y.

Machines and Mechanical Devices

FASTER CUTTING AND APPLYING MACHINE—For adhesive tape, wherein the tape is automatically fed and the surface moistened and the tape cut and pressed almost simultaneously. Patent 1636611. F. T. McGlynn, 110-36 177th St., Jamaica, L. I., N. Y.

HAND DEVICE FOR CUTTING AND POLISHING DIAMONDS—Which can be operated by unskilled labor and is so constructed that the operator is positive that the diamond will not be overground. Patent 1636671. A. Anzelewitz, 27 Rue Queltin, Antwerp, Belgium.

ADDRESSING MACHINE—Which allows addresses to be easily printed by the use of thin stencils made by a typewriting machine. Patent 1637938. E. Heuze-Beauregard, c/o Office Picard, 97 Rue St. Lazare, Paris, France.

SEPARATOR—Particularly useful in the recovery of natural gasoline from natural gas, by mechanically producing foam, and thereby increasing surface contact between the oil and gas. Patent 1637947. M. H. Kotzebue, 1526 So. Victor St., Tulsa, Okla.

WELL SCREEN—Having a spring screen body made up of a plurality of convolutions, which may be readily adjusted to afford a trap for fine sand. Patent 1638731. H. E. Hanson, Nevis, Minn.

TORPEDO HOOK—Which will prevent premature explosions in lowering torpedos or explosive shells into oil wells, and permit the release at the proper point, in "shooting" the well. Patent 1638678. O. Bond, Sapulpa, Okla.

Prime Movers and Their Accessories

STEAM BOILER—Having novel means for feeding water to the vaporizer elements in such manner as to insure the equilization of steam pressure within all parts of the device. Patent 1637929. C. J. Carlson and O. M. Elton, Lexington Aptmt., Helena, Mont.

INTERNAL-COMBUSTION ENGINE—Of simple and durable construction, utilizing all the energy in the fuel to produce maximum power, highly flexible in operation, and minimizes vibration. Patent 1637958. F. N. Newson, 245 Garfield Ave., Salt Lake City, Utah.

Pertaining to Recreation

TALLY—Or indicator for use in the playing of games, such as dominoes, with means for preventing the headed pins from being completely removed, although readily shifted. Patent 1637211. B. B. Bley, 1009 So. 15th St., Waco, Texas.

GAME BOARD—Of the type used in playing checkers or chess, affording a clear playing surface, yet providing pockets for releasably, holding the counters or men. Patent 1637922. F. A. Sullivan, 609 W. Market St., Bethlehem, Pa.

BOWLING PIN—A method of reconstructing an old and worn pin to precisely the same dimensions as in its original state, thereby effecting economy. Patent 1635472. G. P. Geiser. 3953 Janssen Ave., Chicago, Ill.

TOY PUMP—Wherein a spring motor and other parts of the structure are securely held in position, so that they will withstand hard usage. Patent 1635978. J. A. Ross. 147 Prospect St., Nanticoke, Pa.

DIVING BOARD—In which that portion of the board behind the fulcrum flexes so as to lend a higher degree of resilience without undue strain

(*Continued on page* 480)

Patent 1635204. W. S. Brown, 703 Nevada, Urbana, Ill.

AMUSEMENT DEVICE—Consisting of a target at which balls are adapted to be manually thrown, a padded support functioning to minimize the scattered fragments of the broken targets. Patent 1636645. I Noda, Broadway, cor. West 15th St., Coney Island, N. Y.

FIGURE TOY—Simulating a human being swinging a golf club as in the act of putting, success depends largely upon skill in manipulating the toy. Patent 1636042. F. E. Buckberg, 5617 Indiana Ave., Chicago, Ill.

Pertaining to Vehicles

AUTOMOBILE JACK—Capable of quick and easy attachment to the rim of a wheel, and when attached will cause elevation from the ground upon the wheel being rotated. Patent 1634391. J. T. Amiss, Triad Bldg., Baton Rouge, La.

AUTOMOBILE LOCK—For locking the steering post of an automobile against turning and simultaneously to break certain important electrical circuits, for example the ignition, lighting and horn circuits. The inventors have been granted two patents of a similar nature. Patents 1635079 and 1635080. V. L. Gilpin and C. R. Wells, 3058 Dupont Bldg., Coincidental Lock Co., Wilmington, Del.

SAND BAG—Adapted for use within, and conforming to the interior of a tire or shoe, to hold the same in shape when under pressure, during the vulcanizing process. Patent 1635094. E. Nestler, % Nestler Rubber Fusing Co., 245 W. 55 St., New York, N. Y.

CIRCUIT-CONTROLLING APPARATUS—Adapted for use in controlling the bright and dim lamps of head lights, and maintaining control of the steering wheel during such operation. Patent 1625832. M. A. Stein, % Mays & Rouse, 1720 Llewellyn Ave., Norfolk, Va.

STEAM GENERATOR—For steam automobiles, the generator being made up of a plurality units each receiving a small volume of water, and being automatically cut-off should they burn out or break. Patent 1634604. H. S. Anderson, % Santa Fe R. R., Phoenix, Arizona.

ANIMATED WIND-OPERATED ORNAMENT—Adapted for use on radiator caps, the device represents ornamental figures, to which the wind imparts movement, and includes a supporting bracket. Patent 1635937. S. Grillo and J. Guerra, 8890 Lake Ave., Tuckahoe, N. Y.

VEHICLE LEVELING DEVICE—Particularly useful in connection with cotton picking machines, to permit of adjustment of the main frame in picking from high and low plants. Patent 1636620. H. N. Berry, % H. A. Gamble, Greenley Bldg., Greenville, Miss.

GARAGE—In which a maximun number of cars may be stored in a minimum of space, and handled with ease when moving into or out of the garage. Patent 1636600. E. Geiger, 121 Washington Ave, Irvington, N. J.

TENSOR SYSTEM—Which can be rapidly put into action of producing a powerful tension to the lateral chains of a non-skid outfit, as applied to tires. Patent 1636633. A. G. Hartung, % G. Breuer, Maipu 671 Buenos Aires, Argentina.

CLUTCH-PROTECTING DEVICE—In the nature of a foot pedal, adapted to sustain the pressure of the foot against movement when resting inactive upon the clutch pedal. Patent 1636959. C. M. Hibbets, Claude, Texas

FLUID TRANSMISSION—Designed as a substitute for the gear shift and clutch mechanism, can be controlled by a foot pedal to vary the speeds from "high" to "low." Patent 1637968. M. D. Simpson, 560 Rogers St., Brooklyn, N. Y.

VULCANIZER—A repair element for the vulcanization of air-tubes for tires, comprising a metal cup, a rubber patch, a combustible composition and ignition means. Patent 1637931. P. F. M.A. Fontana, c/o C. Chassevent, 11 Blvd. de Magenta, Paris, France.

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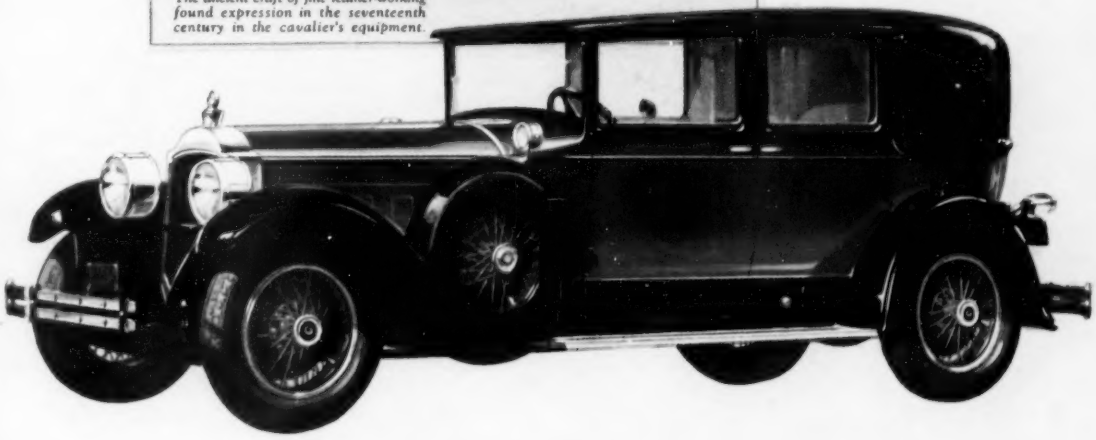

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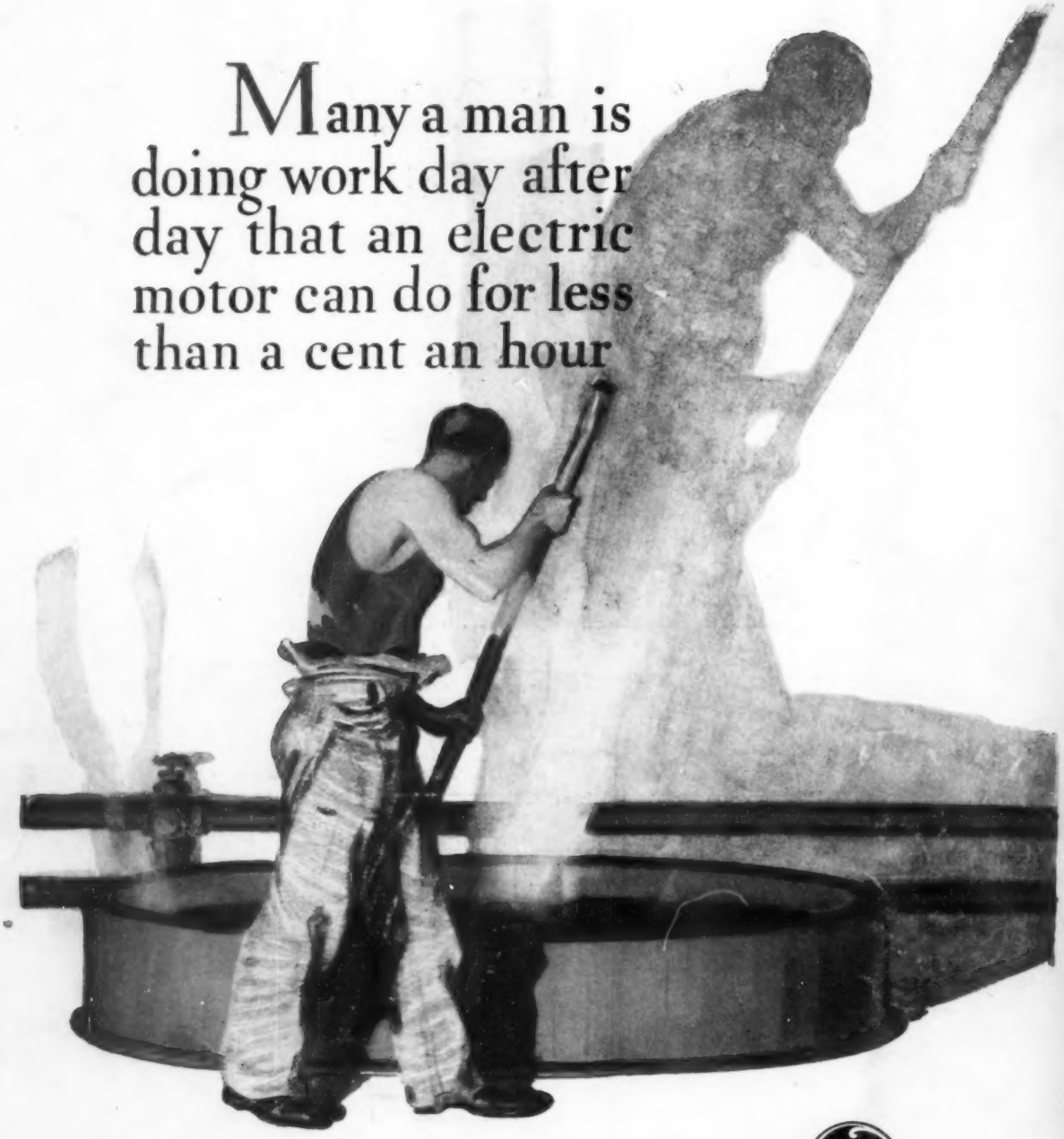

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